The Shelterbelt “Scheme”: Radical Ecological Forestry and the Production of Climate in the Fight for the Prairie States Forestry Project

A Dissertation

SUBMITTED TO THE FACULTY OF

UNIVERSITY OF MINNESOTA

BY

MEAGAN ANNE SNOW

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Dr. Roderick Squires

January 2019

Acknowledgements

From start to finish, my graduate career is more than a decade in the making and getting from one end to the other has been not merely an academic exercise, but also one of finding my footing in the world. I am thankful for the challenge of an ever-evolving committee membership at the University of Minnesota's Geography Department that has afforded me the privilege of working with a diverse set of minds and personalities: thank you Karen Till, Eric Sheppard, Richa Nagar, Francis Harvey, and Valentine Cadieux for your mentorship along the way, and to Kate Derickson, Steve Manson, and Peter Calow for stepping in and graciously helping me finish this journey. Thanks also belong to Kathy Klink for always listening, and to John Fraser Hart, an unexpected ally when I needed one the most. Matthew Sparke and the University of Washington Geography Department inspired in me a love of geography as an undergraduate student and I thank them for making this path possible. Thank you is also owed to the Minnesota Population Center and the American University Library for employing me in such good cheer. Most of all, thank you to Rod Squires - for trusting me, for appreciating my spirit and matching it with your own, and for believing I am capable.

To my friends and fellow graduate students, Jennifer Kotting and Victoria Downey, thank you for always listening, always understanding, and always laughing. I am so lucky to have found such brilliant friends for life in you. Thank you also to Jacob Barney, without whom I would never have made it to the end. I am thankful for Ursula Lang, Timothy Currie, Harlan Morehouse, Erin Walsh, Brooke Bernini, Renata Blumberg, Kyle Green, Basil Mahayni, Bill Lindeke, Katharine Kindervater, Sami Eria, Ben Alden, and Dudley Bonsal, for friendship and camaraderie that meant everything along the way.

Most of all, gratitude is owed to my family, whose enthusiasm for my education has never faltered. Laurel, thank you for forging a life path of meaningful choices that I have been so lucky to follow behind as your little sister – I wouldn't be me without you. Thank you, Mom and Dad, for your endless love and support; for always listening to me, and in so doing, teaching me that my thoughts could matter. Final thanks go to my grandparents, Robert & Stevie Crisson and Janet Scurlock, who I think of and miss daily, and who I hope to always make proud.

Abstract

In 1934 the Franklin D. Roosevelt administration announced the creation of the "largest project ever undertaken in the country to modify climate and agricultural conditions." The Shelterbelt Project, later known as the Prairie States Forestry Project, was designed to alter local climatic conditions around the 100th meridian through the planting of large bands designed to slow the winds and conserve moisture in the soil. The Shelterbelt Project was made possible by the work of radical foresters who were fighting within their field to establish forestry as its own ecological science with a vital role to play in public service. Raphael Zon and his colleagues translated Roosevelt's broad vision into a technical scientific plan and set themselves apart by embracing forestry as relational and inherently political, acknowledging both that economic drivers contribute to climatic shifts, and that environmental and climatic problems have the potential to be mitigated through political solutions.

This project uses archival material and the academic writings of project stakeholders to demonstrate how the spatial ontologies of the Shelterbelt Project's advocates and critics produced different conceptions of climate. It also traces how their thinking affected the types of science they saw as legitimate and the policy solutions they fought for. Though some academic geographers involved with the debate around the Shelterbelt Project wrote explicitly about space, for others, understanding their view of space comes from examining how they viewed the relationship between society, politics, and the environment.

Geographers Carl Sauer, Isaiah Bowman, and Ellsworth Huntington fundamentally disagreed with Zon and other ecological foresters about the best way to combat climatic

instability because their own spatial ontologies always predicated human geography (including political and social solutions) on top of what they saw as an unchanging set of naturally occurring environmental conditions. Focusing on land-use policy and population resettlement as the solution to climatic instability, these geographers ignored the ways in which economic systems were exacerbating environmental differences, casting changes as naturally-occurring in order to remove environmental solutions from the realm of political debate and to insert their own political expertise after the fact as a solution. These actions amounted to a geographical production of climate through the logic of regional and deterministic geography.

Table of Contents

List of Tables and Figures

Table of Shelterbelt Debate Stakeholders

George P. Ahern*	Forester	US Army Lt. Colonel, friends with Pinchot. Headed the Philippine Bureau of Forestry from 1900-1914.
Carlos G. Bates*	Forester	US Forest Service. Associate Editor of the *Journal of Forestry* (1925-1931). Involved in drafting initial Shelterbelt plans.
Isaiah Bowman	Geographer	President of John Hopkins University, Chairman of the National Research Council, Director of the American Geographical Society
Herman H. Chapman	Forester	Professor of Forestry, Yale Forest School. President of the Society of American Foresters
Earle H. Clapp*	Forester	Chief of Forest Service's Research Branch (1915-1935), Associate Chief of Forest Service (1935-1939), Acting Chief of Forest Service (beginning 1939)
Bernard Fernow	Forester	Chief of the USDA Division of Forestry (1886-1898), Dean of the Cornell School of Forestry (1898-1903)
Emanuel Fritz	Forester	Professor of Forestry, University of California Berkeley. Associate Editor (1928-1930) and Editor in Chief (1930-1932) of the *Journal of Forestry*
Henry S. Graves	Forester	Co-founder of the Yale Forestry School, Chief of the US Forest Service (1910-1920)
Ellsworth Huntington	Geographer	Professor of Geography, Yale University. President of the Association of American Geographers (1923), President of the Board of Directors of the American Eugenics Society (1934-1938)
Royal Shaw Kellogg	Forester	Director for the American Pulp and Paper Association
Leon F. Kneipp*	Forester	Assistant Chief, US Forest Service (Land Acquisition)
Walter. C. Lowdermilk*	Forester	Assistant Chief, US Forest Service (Research Division), later Assistant Chief of the Soil Conservation Service
Robert Marshall*	Forester	Founder of the Wilderness Society (1935), Chief of Forestry in the Bureau of Indian Affairs (1933-1937), Head of Recreation Management in the US Forest Service (1937-1939)

Edward N. Munns*	Forester	Involved in creating initial Shelterbelt plans, later the Head of the US Forest Service's Division of Silvics
Gifford Pinchot*	Forester	Chief of the US Forest Service (1905-1910), Governor of Pennsylvania (1923-1927, 1931-1935)
Franklin W. Reed	Forester	Executive Secretary of the Society of American Foresters, previously spokesman for the National Lumber Manufacturer's Association
Edward C. M. Richards*	Forester	Tennessee Valley Authority
Paul Roberts	Forester	Project Director, Prairie States Forestry Project. US Forest Service.
Franklin D. Roosevelt	Politician	Hobbyist Forester and President of the United States
Carl Sauer	Geographer	Professor of Geography at University of California Berkeley
Ward Shepard	Forester	Economic Advisor to US Commissioner of Indian Affairs (1933-1936), Director of the Harvard Forest School (1936-1939)
Ferdinand A. Silcox*	Forester	5th Chief of the Forest Service (1933-1939)
William M. Sparhawk*	Forester	US Forest Service, Division of Economics. Authored "Forest Resources of the World" (1923) with Raphael Zon.
C.W. Thornthwaite	Geographer	Professor of Geography at University of Oklahoma
Raphael Zon*	Forester	Technical Director, Prairie States Forestry Project. Director of the Lake States Experiment Station.

*Signatory to 1934 Zon Petition

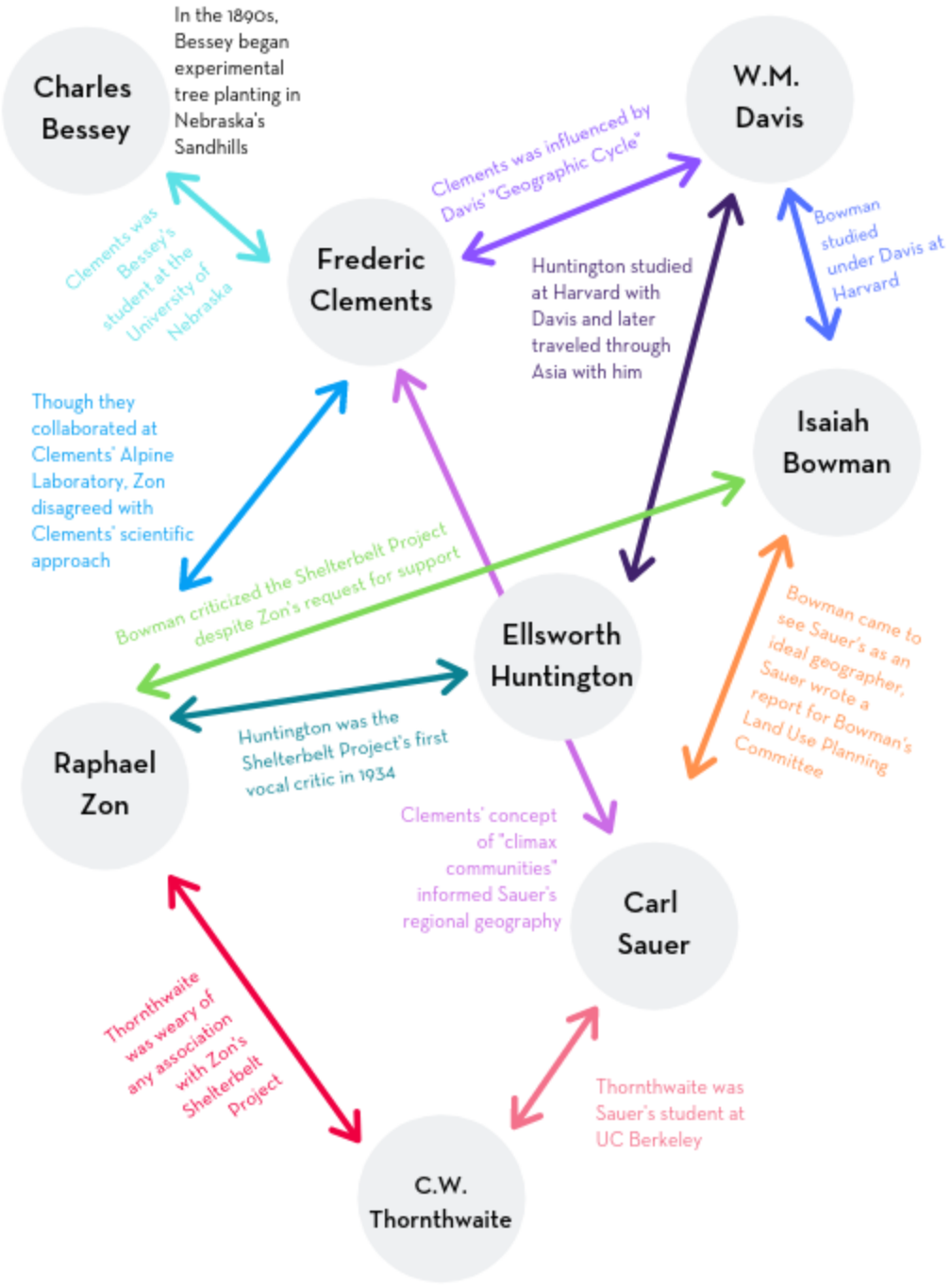


Figure 1: "Zon's Relationships Outside of Forestry"

Introduction

This dissertation is an exploration of the characters, relationships, ideas, and debates surrounding the Shelterbelt Project, a massive tree-planting program which set about to alter local climatic conditions around the 100th meridian between 1934 and 1942. The following chapters detail the fight for the project, paying close attention to the beliefs and ontologies of the project's foremost advocate, forester Raphael Zon, and the project's biggest critics, whose livelihoods spanned both forestry and geography.

When I began this project, I was in search of answers to basic questions about the Shelterbelt Project unanswered by existing literature. The Shelterbelt Project is often remembered in popular conception as "a harebrained, hastily conceived make work scheme that flopped after wasting a potful of the taxpayer's money,"[1] but criticisms of the project were broad and often non-specific. Academic writing on the Shelterbelt is few and far between, leaving fundamental questions unanswered: where exactly did tree planting occur within the Shelterbelt Zone? How successful was it? Was the project based on solid science, or was, as its critics claimed, it merely a work-relief program thrown on top of questionable science? Initially, I looked to the archival record for clues to answer these questions, specifically hoping to find a wide trove of planting maps. I first went to the National Archives in Kansas City, and later I was able to work with employees at both the Minnesota Historical Society and the Nebraska State Historical Society to examine the papers of the Shelterbelt Project's Program Director, Paul Roberts, and Technical Director, Raphael Zon. Quite surprisingly, when examined criticisms of the project, and read Zon's letters, I ran across names familiar to me as a geographer: Ellsworth Huntington, Carl Sauer, Isaiah Bowman. I was already familiar

with the modes of spatial thinking these men propagated from my knowledge of the history of geography as a discipline. Though I had been aware of Shelterbelt Project criticism broadly, upon the realization that these specific geographers formed a core backbone of the pushback against the project, it was clear to me that existing writings on the Shelterbelt Project were missing a huge part of the story: namely, who these critics were, what they themselves believed and fought for, and the personal and professional relationships that existed beyond the text in newspapers and journal articles (see Figure 1: "Zon's Relationships Outside of Forestry). It also began to feel increasingly clear, as I argue here, that the divide and debate about the Shelterbelt revolved around the spatial ontology of its protagonists, making the Shelterbelt Project an important example of the ways in which space itself feeds into justifications for the role of politics and policy solutions in climate science.

I use material found in the archives I visited and the academic writings of project stakeholders to demonstrate how diverging spatial ontologies produced different conceptions of climate among project advocates and critics. I trace how these ontologies affected the type of science project stakeholders saw as legitimate and which policy solutions they fought for. Though some academic geographers involved with the debate around the Shelterbelt Project wrote explicitly about space, for others, understanding their view of space comes from examining their understanding of the relationship between society, politics, and the environment. I argue that critical differences in the spatial ontology of project stakeholders resulted in warring conceptions of climate and, so, competing policy solutions for addressing climatic risk. The Shelterbelt Project was, at its core, a fight between ecological foresters who understood climate as produced – a

continual product of human and environmental history – and those who cast climate as a static set of environmental relations. This re-telling of the Shelterbelt Project aims to demonstrate three things: (1) the Shelterbelt Project itself was irrevocably shaped by conflicting views of space and climate among both foresters and geographers, but – perhaps more relevant for modern geography – (2) spatial ontology sits at the center of how we understand climate, and (3) working toward ongoing concerns for climate equity in the face of climate change will necessitate continual resistance against the idea that climatic and environmental conditions are static, endemic, or equated with the character, quality, or worthiness of an area's residents – and there is a role for geographers in that fight.

The first chapter of this dissertation will detail the history of forestry in America, making clear the linkages between the climate of the Great Plains, tree-planting, and the American project of nation-building. The second chapter will focus on the beginning of Raphael Zon's career in the Forest Service, explaining how his ecological approach to forestry challenged many of the philosophical stakes of traditional forest management. The second chapter also sets the groundwork for understanding the first group of Shelterbelt Project critics: foresters in the Society of American Foresters. In Chapter Three, I will focus on initial scientific plans for the Shelterbelt Project and the work that Zon and his colleagues performed to enable Roosevelt to officially launch the project. In Chapter Four, I take a look at the project's second group of critics: geographers. The fourth chapter explores climatic determinism and regional geography, situating both strands of geographic thought within the evolution of American academic geography and explaining the spatial ontologies of Shelterbelt critics Ellsworth Huntington and Isaiah

Bowman. Chapter Five explores the first criticisms and negative press action to the project and details how Zon unsuccessfully sought out support from geographers such as Bowman and Thornthwaite to support him in the wake of project criticism. Chapter Six demonstrates how geographic theories of climate, specifically regional geography, played out during the New Deal and Bowman's Science Advisory Board. Chapter Seven finishes tracing how these competing ideologies and individual actors shaped the trajectory of the Shelterbelt Project as it unfolded. Chapter Eight examines Shelterbelt Project from a different angle: a digitization of Shelterbelt plantings as reflected in USGS Topographic Quadrangle Maps that begins to answer the most fundamental question that drove my project in its initial stages. A geographically weighted regression of digitized project plantings reveals that economic variables are a better predictor of Shelterbelt planting distributions than physical indicators. These finding reinforce that claims against the scientific feasibility of the Shelterbelt planting plans were always untenable.

Figure 2: "First Shelterbelt Project Plantings in Greer County, Oklahoma (2016)"

Chapter 1: The Great American Desert

Introduction

During the late 19th century, white American settlers travelled west into the interior of North America, following newly constructed railways to new economic opportunities on the Great Plains. Once nicknamed the Great American Desert, early writers, scientists, and explorers long deemed the Great Plains uninhabitable for white settlement due to low annual precipitation numbers, its treeless expanse, and its non-white inhabitants. A desire to fill the Plains with white settlers fueled government land lotteries, the expansion of railroads, and the destruction and displacement of Native American communities, reshaping the economic potential of the interior of the continent for white Americans.

Despite these efforts, the United States government still struggled to fully settle the interior of North America. Low annual precipitation numbers to the west of the 100th meridian made the line a practical stopping point in the process of westward expansion. Beyond simply a practical concern, the climate of the Great Plains was viewed as not only a problem of the natural world, but a social and societal problem as well. Theories abounded that though such a dry climate was not fit for proper white settlement, the arrival of white civilization held the potential to change climatic conditions on the Plains for the better. Settlers were coaxed westward on the promise that the dry plains held the promise of transformation into an agricultural paradise through hard-working of the land and planting of trees. Trees were seen a tool for providing a myriad of environmental, cultural, and social benefits.

As Americans moved west, their struggle to plant trees on the Plains was compounded by the rate at which eastern timber stands were clear-cut to create room for settlements and provide timber for practical uses. The early 20th century saw the creation of a hard-fought forestry profession in the United States, one that asserted itself as uniquely American and broke with traditions of Old-World European forestry. These early American foresters asserted forestry as not merely a profession, but also as a science.

The Great American Desert

The 19th century image of an American Empire was driven by "a relation between man and nature – or rather, even more narrowly, between American man and the American west." [2] The mythology of a Western agricultural paradise prosperous enough for the average settler to make a good life propelled expansion westward as Americans aimed to capture and realize this vision for themselves and sat at the foundation of how Americans came to see ideal settlement. The government's dream of filling the interior of the continent with white agricultural settlements would not come easily, and was in large part predicated on otherizing the people and places that did not meet this ideal. To white American settlers, treeless prairies were foreboding and unsuitable for agriculture. Largely pulling from racist stereotypes of Asian nomadic tribes and Native Americans, popular and literary visions for the Great Plains portrayed the white men who dared to live there as inevitably succumbing to roving bands of miscreants, outlaws, and barbarism.[3]

Zebulon Pike warned of the American desert that lay east of the Mississippi during his 1806-1807 westward travels, referring to the area as a "sandy sterile desert."[4]

His account served to compound dispatches from those who passed through the region in the 1820s and 1830s on their way to the Pacific. The common word used to describe the area was "uncivilized." The Scientific Expedition of Major Stephen H. Long lasted from 1819 until 1820 and focused on the southern and central plains. The Long Expedition contained both a zoologist and a botanist and published written records, visual records, and maps. In describing portions of the Plains, Long proclaimed that the area was "almost wholly unfit for cultivation" and "uninhabitable by a people depending on agriculture." His map accompanying the narrative marked the plains as a "Great Desert."[5]

The only option going forward would be to either abandon the Plains altogether, or to find a new way to 'civilize it' in the image of the white eastern United States. The Indian Removal Act of 1830 gave President Andrew Jackson domestic power to 'exchange' tribal land east of the Mississippi River for land to the west. By the 1850s, the western-most line of white population was the 97th meridian, which fell in eastern Kansas and Nebraska. Lt. Governor K. Warren described settlers in that area as being "upon the shores of a sea, up to which population and agriculture may advance, and no further."[6] Shifting political dynamics before the dawn of the Civil War spurred the Kansas-Nebraska Act in 1854, while Southern succession in 1861 allowed for passage of the 1862 Railroad Act, settling on a northern route for the first transcontinental railroad.

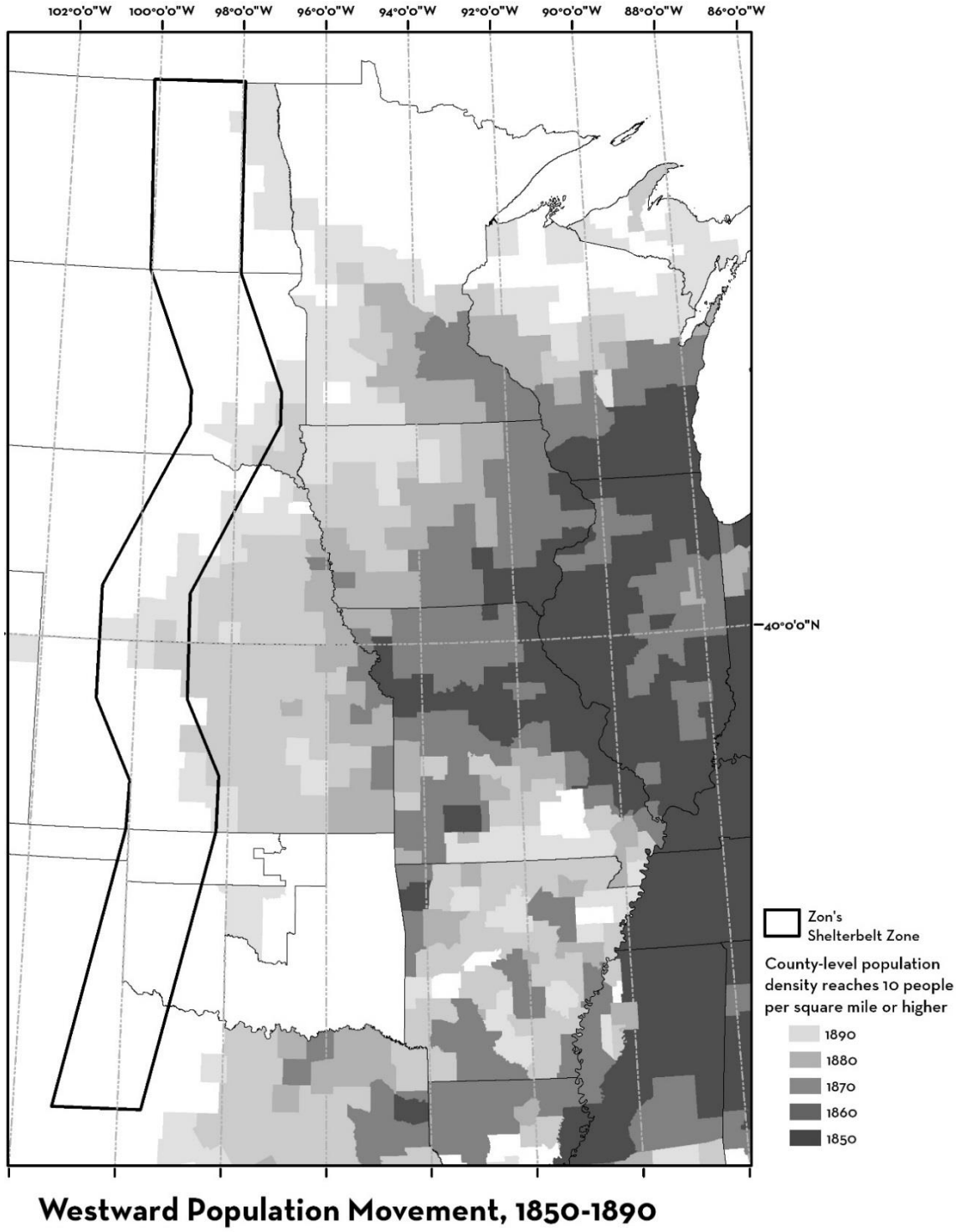


Figure 3: "Westward Population Movement, 1850-1890"

By the close of the Civil War, focus shifted back to the Homestead Act, which had been passed right before the war began in 1862 and demarcated the 'opening of the west.' The Homestead Act allowed settlers to claim 160 acres of land on the condition that they would cultivate it for at least five years. In 1866, the US government used the support of some Native tribes for the Confederacy as a basis to seize nearly half of the land previously set aside for Native Americans.[8] As settlement struggled to move further west, a new economic interest in the potential of the west collided with a sudden spike in the belief that the civilization of western settlement itself could increase precipitation. Between the years 1865 and 1875, this belief was propagated by scientists and newspapers alike.[9] As explorer and naturalist Josiah Gregg wrote in *Commerce of the Prairies*, "Why may we not suppose that the genial influences of civilization – that extensive cultivation of the earth – might contribute to the multiplication of showers, as it certainly does of fountains? Or that the shady groves, as they advance upon the prairies, may have some effect upon the seasons?"[10]

By the 1860s, some of the Midwestern states began implementing small-scale tree planting programs of their own. In 1868, Kansas offered two dollars an acre to anyone who cultivated timber successfully for three years, and soon Nebraska had a similar law. The trees themselves were seen as "a civilizing agent to be stewarded… to capture the collective imagination of the nation."[11] Ferdinand V. Hayden, one of the most eminent geologists working in the west during the 1870s, suggested in the First Annual Report of the United States Geological Survey of the Territories that trees should be planted along the eastern edge of the prairie on the basis of their potential to change the climate:

"The settlement of the country and the increase of the timber has already changed for the better the climate of that portion of Nebraska lying along the Missouri, so that within the

last twelve or fourteen years the rain has gradually increased in quantity and is more equally distributed through the year. I am confident this change will continue to extend across the dry belt to the foot of the Rocky Mountains as the settlements extend and the forest-trees are planted in proper quantities."[12]

Hayden had been influenced by the 1864 publication of *Man and Nature* by George Perkins Marsh, and he quoted Marsh to help bolster his argument for his theory. Hayden had an interest in the idea of an American Empire, and the settlement of the Plains by civilized Americans would be crucial to its success. As he wrote in 1871, "it is my earnest desire to devote the remainder of my life to the development of its scientific and material interests, until I shall see every Territory, which is now organized, a State in the Union."[13]

Railroad companies began planting trees along the railroad routes that coursed through vast stretches of dry grassland as they worked their way across the prairie in the 1870s and 1880s. Arbor Day, now commonly thought of as a day to think about environmental stewardship, began as a call to arms in 1872 to encourage tree planting on the Great Plains. Trees were a tool for providing a myriad of environmental, cultural, and social benefits. They helped with practical concerns, such as providing shade and relief from the wind, as well as social and cultural benefits, such as making the surrounding area a happier and more desirable place to live. J. Sterling Morton, founder of Arbor Day, first appealed to the Nebraska State Horticultural Society about the importance of tree planting by declaring:

"There is comfort in a good orchard, in that it makes the new home more like the "old home in the East…Orchards are missionaries of culture and refinement. They make the people among whom they grow a better and more thoughtful people. If every farmer in Nebraska will plant out and cultivate an orchard…this will become mentally and morally the best agricultural State."[14]

The goal of cultivation of the prairie states as an agricultural settlement carried with it racial and moral implications, as it was seen that the quality of the land itself would help dictate the type of human settlement that sprung forth from it. Samuel Aughey, Professor of Natural Sciences at University of Nebraska stated:

"What then [he asked] may we legitimately expect of the people in Nebraska in the future? We have a right to expect that our school system will reach the highest possible stage of advancement - that the great mass of the people will become remarkable for their intellectual brightness and quickness. Along with this natural development and synchronizing with it, there will be developed a healthy, vigorous and beautiful race of men and woman. Art culture will then receive the attention which it deserves… the marvelous richness of our soils will give a true and lasting basis for prosperity and wealth. For be it remembered that agriculture in all its branches, endures the tests of time better than any other industry. It is also the best school of virtue for a nation. Happy the children that are trained to industry on a farm. More men and women of high character and endowments come from the farm, than from any other station. It is nearest to the heart of nature and nature's God."[15]

If the fertility of the soil itself was to deliver civilization to the Plains, the soil itself would need help. Over a million trees were planted in Nebraska on the first Arbor Day alone. The following year, the Timber Culture Act of 1873 created a "tree claim" for homesteaders. Homesteaders were able to claim up to 160 acres of land on the condition that they planted trees on 40 of those acres and maintained those trees for at least ten years. In spite of this, westward settlement still struggled around the 100th meridian. Between 1870 and 1890, farmers found that traditional farming techniques were not adequate to handle the shortage of rainfall as they moved further west into the plains.[16]

Advertising an 'Evolving' Landscape

In an attempt to increase the rate of settlement, large land and cattle corporations operating out west in states such as Kansas and Nebraska issued pamphlets and advertisements sent back east to lure new residents to the Great Plains. Railroad

promoters aimed to coax settlers further and further west with the goal of bringing more agricultural settlement in sections of the Great Plains that had so far remained exclusive to cattle ranching. In order to do this effectively, promoters needed to fight the image of the Great Plains as the Great American Desert.[17] Advertisements were geared toward potential investors and future settlers, eastern outsiders who had never themselves seen the land being described. The content and framing of the advertisements was influenced by the new and widespread interest in evolution and biological process. Americans were beginning to tie together ideas of social progress with a newfound ability to solve society's problems with science, and they anticipated such progression would take place in the interior of the continent.[18] Pamphlets were therefore designed with a heavy reference to the potential of the Plains, rather than their current state.

Promoters attempted to showcase evidence of new environmental changes to render negative stereotypes of the Plains inaccurate. An 1869 account of the "Resources of Nebraska," directly discussed the "unjust" representation of Nebraska as a Great American Desert – lies perpetuated by history books and maps. The brochure encouraged a specific effort from those already familiar with the area's climate and soil to help combat how undeservedly and unfairly "unsettled and unimproved" the area remained.[19] Flowery descriptions of landscapes helped to attract potential settlers by presenting them with imagery that created a sense of variety and drove away images of monotonous or austere environments. The Kansas Pacific Railway described the Kansas landscape as a "vision of beauty" filled with forests, streams, green prairies, farm houses, corn, and wheat. Though it was once "thought of 'as a vast sand plain, fit only to be roamed over by savage beasts and more savage men,"[20] advertisers declared those days

over. An 1887 advertisement produced by the Burlington Route claimed that in the previous six years alone, a rain belt had moved west and dissipated dry conditions in the area.[21] Rumors of increased precipitation following settlement continued to abound during this period.

At work in both 19th century definitions of the Great Plains – first uninhabitable, then suddenly ripe for settlement – was the production of nature and the logic of climatic determinism. Climatic determinism applies biologic metaphor to space itself, making claims of a determinant link between geographic differentiation of the earth and variation in the value of human societies and races. Proponents of climatic determinism used naturally occurring global differentiation as proof of the inherent biological inferiority of non-white races. Climatic determinists leveraged the supposed scientific basis of their theory to give political legitimacy to western conquest in North America and European colonization and imperialism abroad, while simultaneously building geography as a recognized discipline within the academy.

The production of nature is the process under which capitalism exacerbates the world's natural geographic differences while casting them as naturally-occurring in order to remove them from the realm of political debate. On the Great Plains, a produced nature worked in tandem with climatic determinism to first create the narrative of an uninhabitable Great American Desert, then recast the same space as ripe with agricultural promise after the forced displacement of Native Americans and new investment of capital (largely through railroad and cattle companies) for purposes of production.

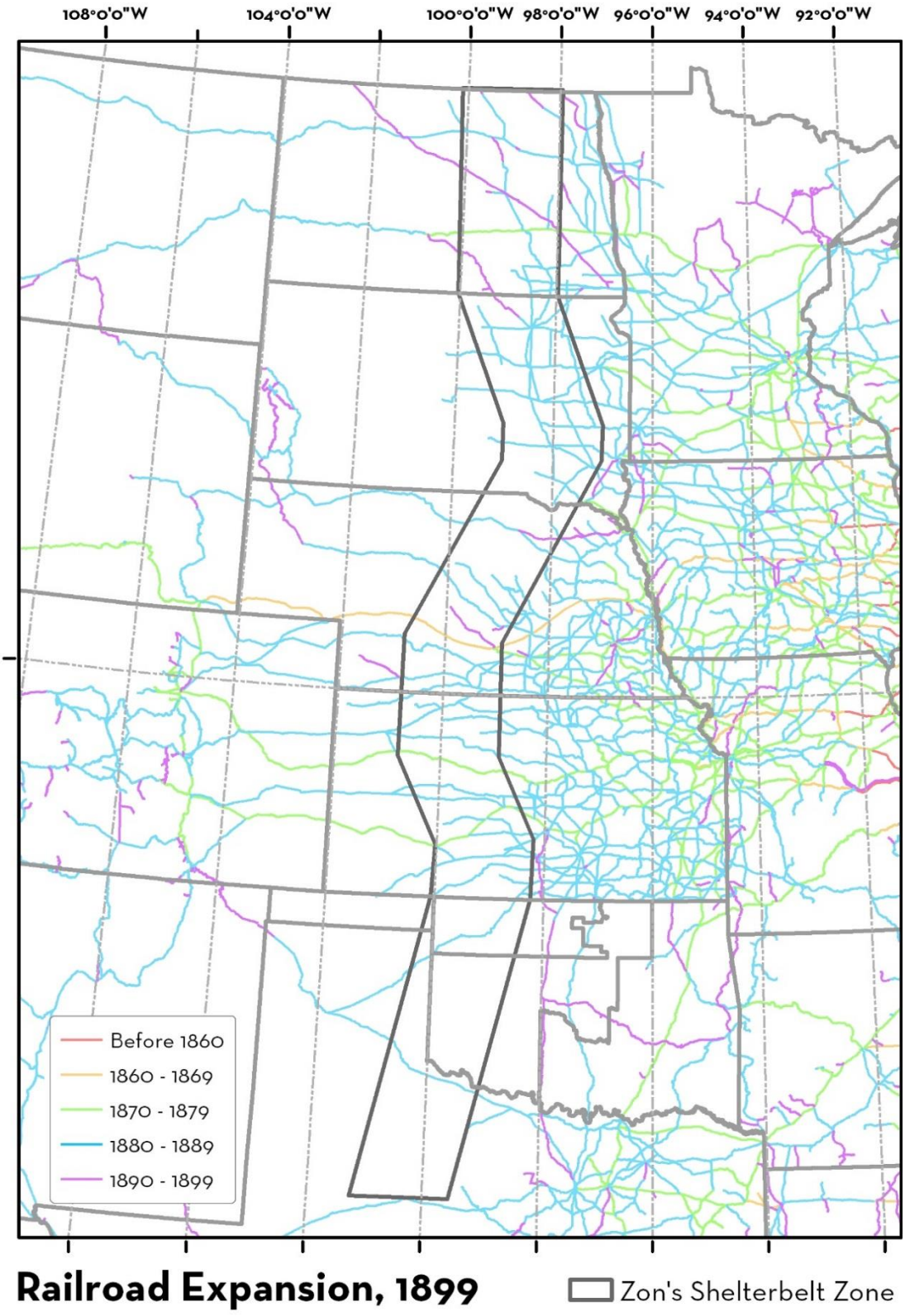


Figure 4: "Railroad Expansion, 1899"[22]

Pinchot Encounters the A Westward Continent

From the time of the country's founding, forests in the United States were largely unregulated. Timber was there for the taking and settlers chopped their way across the continent, cutting down forests to make space for new settlements and using timber to construct them. It would not be until 1897, more than a century after the country's founding, that the Forest Management Act was passed by Congress, bringing American forests under scientific management for the first time. The resulting forestry movement strengthened forest protection through the work of public agencies and federal and state legislation. In the 1890s, settlement continued across the continent at a rapid pace, with big implications for American forests. At the beginning of the 20th century, forestry was still a very new profession in America, working to prove itself to the scientific community at large, and in search of respect and legitimation.

Gifford Pinchot, who would go on to become the very first Chief of the Forest Service, arrived back home in the United States in 1890 as a young forester after training in Europe to encounter a country still without an organized forestry profession, and the country's forests facing rapid depletion. In his words, America was "obsessed" with a "fury of development." As he stated, "the man who could get his hands on the biggest slice of natural resources was the best citizen. Wealth and virtue were supposed to trot in double harness."[23] The government was intent upon giving away forest land to private citizens, and citizens were focused on cutting down all the timber they could before moving on to new lands. In 1891, a partial forest survey demonstrated that over twelve million acres of forestland had burned down through unchecked forest fires, a finding that resulted in little to no public discussion.[24] Pinchot contrasted that with a fire that set

ablaze a mere six thousand acres in Germany that was still talked about ninety years after the fact.[25]

Born to a wealthy New York family in 1865, Gifford Pinchot had been encouraged to go into the forestry profession by his father James Pinchot. Though forest management was actively practiced in Europe at the time, it was not yet organized in the United States. The elder Pinchot owned large timber holdings in Pennsylvania and experienced first-hand the environmental consequences of clear-cutting. After the forests were clear-cut, logs would be shipped downstream to eastern cities, in part to help satiate the demand for lumber required by the railroad companies.[26] Seeing negative effects on the landscape convinced him that forest management would be a necessity in America in the coming years, and he encouraged his son to see the potential in the work for himself. As the younger Pinchot later described the attitude of the time, "public opinion held the forests in particular to be inexhaustible and in the way. What to do with timber? Get rid of it, of course."[27]

Gifford Pinchot first attended Yale University, where he found there were few books available that dealt with forestry. Pinchot spent most of his college years too "fascinated by living to do much thinking"[28] and was not fully decided on a chosen profession, but still strongly considering following the pursuit of forestry on his father's guidance. After graduation, he traveled to Washington, DC to consult government officials on his plans. Dr. Bernhard Fernow, a German forester who at the time was serving as Chief of the Department of Agriculture's Forestry Division, advised Pinchot against pursuing a forestry career. The Bureau had been founded in 1880 to help catalogue the nation's natural resources and was operated by the Department of

Agriculture. But Fernow – who was born to a wealthy landed family in Prussia – had found it difficult to forge a forestry career in the United States, and he discouraged Pinchot based on his own personal experiences.[29] Even under Fernow's lead, the Bureau could not set national policy, it merely gathered forestry-related statistics. There was no clear federal forest system, and all public lands were held under the director of the Department of Interior's General Land Office.[30] Fernow felt that the reality of the day was that forestry was "impractical" for the United States and encouraged Pinchot to pursue a more broad-based and widely applicable education, such as botany.[31] Not deterred, Pinchot realized that to pursue forestry fully, he would need to leave the United States and seek out forestry resources where they existed. So, out of necessity for his chosen pursuit, he traveled to France in 1889 to begin his education in silviculture at L'Ecole National Forestiere in Nancy, France. There were no American forestry schools in existence at the time, and Pinchot was the first American forestry student to study at the French school.

In Europe, Pinchot was taught 'Old World' forestry, which focused on silviculture, forest management, and forest law. Pinchot himself could not help but notice the social and economic conditions under which Europeans practiced forest management. He later remembered seeing an old Prussian peasant rise to his feet as the "Oberfoerster" came to visit, "silent, head bent, cap in both hands," while the Oberfoerster "stalked by without the slightest sign that he knew the peasant was on earth."[32] Pinchot's view of forestry evolved into an overtly political point of view over time, as he came to believe that forest holdings should be utilized democratically and

equitably. As he would later say, "for whose benefit shall [resources] be conserved – for the benefit of the many, or for the use and profit of the few?"[33]

While in France, Pinchot sought the private counsel of forester Dr. Brandis on the topic of American forestry. Brandis suggested that the United States would need a large private landholder or state government to take initiative and demonstrate the value of forestry to an American audience. Brandis held a somewhat unusual view for his day and age: that forestry can only ever succeed if the opinions of those who live in and around the forest support forest maintenance. Brandis believed that in order for forestry practice to be successful in America, its positive and practical effects must be directly demonstrated to the American public. The desire for forestry was not going to organically emerge as a bottom-up movement, but he believed one could work to generate bottom-up support.

While in Europe, Pinchot continued to seek advice from European forestry officials and experts with which he was able to hold an audience. He found that most advised him to continue to deepen his studies of European forestry. Only one man, Forstmeister U. Meister of Switzerland, suggested that Pinchot's education in forestry was likely already sufficient. In Meister's view, it was fruitless to pursue a continued course in advanced European forestry studies. American forestry would be fundamentally and necessarily different from European forestry, given the economic and political differences of both places.[34] Pinchot needed to go home and learn by doing.

Once Pinchot arrived back in the United States, he was hired to work on the estate of George W. Vanderbilt. Vanderbilt had already hired Frederick Law Olmsted to plan and manage land and gardens of his vast North Carolina estate, and Olmstead suggested

that Vanderbilt invest in timber crop on a 100,000-acre section of his land not suited for parks or garden. Pinchot became the Chief Forester of the Vanderbilt Estate, the first in the nation to grow timber with long-term conservation in mind while employing modern silviculture and tree thinning techniques.[35]

Though Gifford Pinchot served as the first Chief Forester of the Estate, it was German Forester Dr. Carl Schenck who would eventually oversee the addition of 120,000 more acres to the Biltmore Estate after Pinchot's departure, and who administered the Biltmore Forest School from 1898 until its close in 1913. During its operation, the Biltmore Forest School focused on hands-on skills and became an immediate rival for the Cornell School of Forestry. Another competitor appeared with the Yale forestry program, which opened in 1900. Yale's program was established in large part through the efforts of Pinchot, whose family underwrote an endowment of $150,000 for the program.[36] The Yale program was specifically designed to encourage American methods for the American forests, taught by American foresters. The Pinchot family's investment in Yale Forestry paid off, as within a decade, Yale dominated the forestry profession, and would do so for at least four further decades.[37]

Meanwhile, 1891 marked the beginning of experimental planting in Nebraska's Sandhills. Though botanist Charles Bessey wanted to try planting in the area as early as the 1880s, many did not believe it would be successful in an area that regularly received less than 22 inches of precipitation annually. Local ranchers and settlers in the area were initially opposed to the land being used as forest. However, Bernhard Fernow, still the Chief of Forestry for the Department of Agriculture, was looking to make his mark in the federal government. He believed in Bessey's vision and hoped the plantings would

disprove for a wider audience the climatic determinist belief that forest plantings could bring rain. Fernow was opposed to deterministic social Darwinism, arguing that there was "danger and impropriety" in comparing societal development as analogous to plant biology.[38] Bessey convinced a colleague of his, Edgar Brunner, to furnish land for the project in Holt County, Nebraska. Around 20,000 seedlings were planted under the direction of plans created by Fernow in the Sandhills of western Nebraska, consisting mostly of pine (Ponderosa, Jack, Scotch, and Austrian), Black Locust, Black Cherry, Box Elder, and Hackberry.[39]

As railroad companies and others worked to ameliorate settlement further west, the United States government was continually establishing control over more and more territory to be filled. Nearly two million acres of unassigned lands opened for settlement in 1889, and by 1890, nearly 60,000 settlers were in the area and required a territorial government: this was the birth of Oklahoma Territory. The Creek, Cherokee, Choctaw, Chickasaw, and Seminole tribes together maintained control over another 15 million acres officially known as Indian Territory. In 1893, the Dawes General Allotment Act was altered such that Native land controlled by the Five Tribes was no longer held communally but was instead allotted to individual tribe members in plots that ranged between 60 and 320 acres. Individual Native Americans could now lease or sell their land in a way that would not have happened under communal land holding agreements, and though the land was still not immediately open for white settlement, the implications for it in the future were huge. Large tracts of this land were purchased quickly by a minority of wealthy speculators.

During the 1895 meeting of the American Forestry Association, Pinchot advocated for the creation of a National Academy of Sciences Commission on National Forests. As part of Pinchot's call, he argued that Fernow was failing in his job of protecting America's forests. By February of 1896, the Secretary of the Interior called for the National Academy to establish he commission, and later the same month, President Cleveland followed the suggestion of the new Commission on National Forests by setting aside 20 million acres of forestland on which forestry could be practiced. Fernow viewed both the call and the reserves as an affront to his tenure, believing that Pinchot's group was only creating competition to his own work, especially given that Fernow himself was not invited to participate in the Commission, on which Pinchot was appointed Secretary. Fernow was left feeling challenged and unappreciated.[40] Just two years later in 1898, Fernow resigned to become the first year of Cornell's School of Forestry. This would only last for five years, as the state of New York ultimately pulled funding for the school in 1903, effectively killing the future of Fernow's forestry career in the United States.[41]

Pinchot accepted a job as the head of the United States Bureau of Forestry after Fernow's departure in 1898. Pinchot was able to expand the Bureau's budget and workforce while networking in Washington with other like-minded public servants. Pinchot's embrace of national politics and a political forestry set him apart not only from Fernow, but from the long-standing traditions in Old World forestry.[42] The Division of Forestry was still closely tied to the business of meeting the needs of private land owners, and Pinchot necessarily tried to convince private land owners that logging conservatively could still be profitable.[43]

More than decade after Bussey's plantings, Pinchot, by then Chief of the Bureau of Forestry, sent a team out to look at planting possibilities in the Sandhills, and found the original pine plantings had grown twenty feet tall. Experiments with tree planting were carried out in all of the states of the Great Plains beginning in 1900, and results continued to show that much of the land in the Sandhills largely thought to be worthless could support tree growing without great expense. At the request of Pinchot, in 1902 President Theodore Roosevelt set aside land in the area of the Dismal River and the Niobrara Forest Reserves to continue to experiment with tree-planting (largely done under the direction of Charles R. Scott). This later became known as the Nebraska National Forest, which Pinchot would later describe the project as "one of the great successful tree-planting projects of the world," of which the Shelterbelt Project would become a "direct lineal descendant."[44]

In 1905, President Roosevelt created the Forest Service, and Pinchot was appointed as its first chief. The Forest Service's mission expanded the scope of the Bureau of Forestry, as for the first time, the nation's public forests were transferred from the Department of the Interior to the Forest Service, under the watch of the Department of Agriculture. Pinchot wanted to see equitable distribution of forest resources, but under Roosevelt's watch, he realized that despite Roosevelt's support for conservation, there was still an increase in the corporate control of land and water alike.[45] Pinchot watched carefully as the Taft administration took over, claiming that Taft was on the side of "every predatory interest seeking to gobble up natural resources or otherwise oppress the people."[46]

Confronting the Soil and the Plow

Farmers on the Great Plains were continually challenged by drought, particularly between 1894 and 1896, and again from 1910 through 1913. Agricultural demand during World War I gave hope to many farmers, as American agricultural products supplemented decreased agricultural production in Europe and the war effort demanded materials. The land west of the 100th meridian was finally broken by plows as farmers expanded the capacity of their farms to keep up with production demand.[47]

The 1920s were a time of great economic growth in America, with the national unemployment rate averaging around 3% between 1925 and 1929.[48] Agricultural prices remained high until armistice found European nations increasing their own agricultural production and domestic prices dropped in the United States. Crop prices experienced sharp declines after the First World War and through the 1920s, creating economic instability in agricultural areas. A contributing factor to the plight of Midwestern farmers was relatively new industrial machinery, such as farm plows, which broke the soil up into fine particles to create a soft planting field for seeds. Farmers plowed their fields year after year, creating an increasingly fine soil that was susceptible to blowing away in the winds of the Great Plains. Drought exacerbated the problem, making fine soil particles lighter and more easily blown. As farmers plowed new fields, the native grassland began to disappear, stripping the area even further of a natural barrier designed to help stabilize soil.

After the stock market crash of October 1929, crop prices dropped by as much as 60% and the unemployment rate rose to between 20% and 30% nationally.[49] President Herbert Hoover attempted to stem the economic collapse by appealing to private industry

to retain workers, believing that the government had a minimal level of responsibility for providing economic relief and preferring to see solutions based in private industry. He pursued a largely top-down economic approach, giving emergency money primarily to financial institutions and production facilities, though he did advocate for boosting employment to some degree through public works projects.[50] It would not be until Roosevelt was elected President in 1932 that federal economic policy shifted to a bottom-up approach with unprecedented levels of government-funded relief efforts.

At this time, the Plains region in particular was going through "physical and human torment"[51] as the financial depression combined with the ongoing drought. The needs of rural drought-affected regions created a poverty crisis "larger than anything the Red Cross had ever had to meet" by the winter of 1930 and 1931.[52] Blowing winds scattered dry soil across the prairie, creating huge dust storms that clouded the skies and deposited Midwestern soil as far east as Washington, DC. These dust storms compounded existing challenges with crop growth, caused depopulation, increased homelessness, and in some cases led to "dust pneumonia."[53] As Paul Roberts, Program Director for the Prairie States Forestry Project, later described the period, "one who did not experience something of the conditions on the Great Plains in those times can but dimly understand their effect on the human spirit."[54]

As the Governor of New York, Roosevelt paid close attention to the impact that falling agricultural prices had on the farmers and promoted and established programs aimed at reversing the state's high farm abandonment rate. Approximately 300,000 New York farms were abandoned during the 1920s alone. His plan to stem the crisis in rural areas included reforesting farmland that was no longer suitable for cultivation and using

regional planning tools to increase the profitability of the farms determined to be suited for cultivation.[55] New York State's rural problems left a lasting impression on Roosevelt and impacted his national policy decisions after becoming President.

Those politically aligned with Roosevelt's New Deal policies believed that agricultural poverty was created through over-worked land and exacerbated by the wealth disparities that helped trigger the Depression. One of the great contributors to rural poverty was a widespread system of farm tenancy. By 1890, prices for cotton, corn, and wheat had all fallen well below the cost of production. Most landlords required tenants to produce cash crops, forcing tenants to compete in a market with low agricultural prices. Tenants were additionally mandated to give anywhere from 25-50% of their crops directly to their landlord as rent payment.[56] There were additional challenging to tenant farming: most local farmers found themselves harvesting and selling their product around the same time as other local farmers, creating a balance of power that rested in the buyers' favor. Many large local merchants employed "street buyers" who made first-round offers to buy crops at low prices. If farmers did not agree to sell at the initial low price, they would often make even lower offers on the second round. To complicate things further, in many rural areas farmers were selling their crops to the same local merchants they needed to buy household supplies from – supplies on which merchants set the price.[57] This virtual monopoly over lines of credit, interest rates, and supply of necessary household and farm equipment trapped many farmers in a cycle of debt it was nearly impossible to climb out of. By 1935, the statewide tenancy rate for Oklahoma was as high as 59% (see: Figure 5: "Average County Tenancy Rates by State, 1910-1935").

	1910	1920	1925	1930	1935
North Dakota	13.9	25.3	34.2	34.9	39.0
South Dakota	22.4	30.6	37.6	42.1	46.1
Nebraska	32.8	39.9	44.7	45.8	48.2
Kansas	32.4	38.9	41.8	42.3	44.3
Oklahoma	55.5	49.5	56.8	59.8	59.7
Texas	40.2	43.5	52.2	53.7	52.5

Figure 5: "Average County Tenancy Rates by State, 1910-1935"[58]

The Shelterbelt Idea

While traveling west through Montana during his 1932 Presidential campaign, Franklin D. Roosevelt's train halted outside Butte for several hours due to a wreck ahead on the tracks. Hot, dry winds carried dust through the train and the view outside the windows was visibly barren. Decreasing farm prices and cycles of debt descended on farms in the Great Plains at the end of the 1920s, compounded by drought and soil erosion from overworked fields. Hardship rose to the level of an economic and environmental crisis, mandating political and economic reform at the national level.

Speaking to a reporter on board, Roosevelt pledged that if elected he would "fill such lands with trees."[59] Roosevelt took an interest in forestry from an early age. He grew up in Hyde Park, New York on 1,200 acres of forested acreage along the Hudson River and later served as Chairman of the Forestry Committee of the New York State Senate while planting up to 3,000 trees annually on his personal property.[60] As a Presidential candidate, he faced the challenge of how to stabilize a country in economic and environmental crisis. Roosevelt's long-standing childhood interests combined with

experienced he gained as Governor of New York led him to believe that stability for climate and agriculture on the Great Plains could be achieved through an investment in forestry. Just months after his inauguration, Roosevelt kept his promise: in May of 1933, Roosevelt sent a note to Major Robert Y. Stuart, Chief of the Forest Service, which read, simply: *"What can be done to plant the Great American Desert?"*[61]

Stuart consulted with Edward N. Munns of the Forest Service to begin drafting a plan that was scientifically feasible and which would meet Roosevelt's needs.[62] On August 15, 1933, Secretary of Agriculture Henry Wallace wrote to President Roosevelt with a memorandum and report entitled "Forest Planting Possibilities in the Prairie Region." The report itself was authored by Raphael Zon, who at the time was the Director of the Lake State Experiment Station in St. Paul Minnesota, and would eventually become the project's Technical Director.[63]

The only form of forestry that had been shown to be effective on the prairies were what were known as "shelterbelts," strips of trees planted for the specific purpose of protecting homes, crops, and livestock from the effects of the wind. More traditional plantation plantings of trees for wood production had been met with less success. Therefore, rather than recommending extensive tree plantations, the report recommended planting trees in 100-foot strips alongside highways and north-south section lines, which would have "advantages over planting in blocks."[64] Though shelterbelts produced negligible amounts of timber other than what could be used directly on an individual farm for fuel, fences, and shelter. Shelterbelts began serving an important role in the agricultural economy of the plains with the first plantings of the Osage orange tree in the early part of the 19th century that helped make possible the very earliest plains

settlements.[65] The experimental idea of rescaling the usefulness of the small farm shelterbelt to a regional scale can be credited to Zon. Roosevelt's interest in foresting the plains could have taken any number of forms, but it was Zon's involvement that would come to shape the fate of the program more than any other factor – both because of Zon's work, reputation, and connections, but critically, also because of his ecological approach to forestry.

Zon was a strong believer in the power of scientific research and held the belief that gathering accurate information upon which to build a management plan should always sit at the foundation of forestry management. Most important was Zon's belief in the primary importance of studying forest interrelationships over individual plant physiography, a take on ecological science that would set him apart from other scientists and foresters.

Zon's report for Stuart and Roosevelt explained the utility of planting shelterbelt strips for wind protection: wind velocities up to twenty miles per hour could be reduced by more than half for up to eight times the height of the shelterbelt itself. This lessening of wind velocity could result in up to sixty percent less evaporation, conserving moisture in the soil for crop growing. The report cited a study which showed that a field protected by a shelterbelt averaged thirty percent more moisture over an area that was twelve times the height of the planted trees when wind gusts ranged between five and twenty miles per hour. It also noted that experimental planting of shelterbelts as windbreaks in Nebraska along corn fields resulted in the fields with shelterbelts yielding fifty-nine bushels per acre, while the unprotected fields were only able to yield forty-one bushels.[66]

The report describes the most effective form of shelterbelt to be a strip of trees at least 100 feet wide and composed of between ten and twenty trees. Smaller, slow-growing shrub-like trees would be planted on the outside of the belt, with the taller, fast-growing trees planted in the center of the strip. These strips of forest plantings would ideally be located about one mile apart from one another for maximum planting efficiency – which just so happed to be the approximate distance between section lines. Given that many of the local roads and highways in the prairie states were built along section lines, Zon muses that it might be possible to simply widen the right-of-way for roads across states in the planting area and use the acquired right-of-way land for tree planting.[67]

At the end of the report, three possible options for carrying out the project are explained: the first option was to have the federal government acquire strips of land and plant shelterbelts directly on the newly acquired land. This would require the most federal resources but would ensure that the federal government would have control over all land and all planting and could thus ensure uniform zone-wide planting. The second option was to have the federal government acquire land and conduct planting in direct cooperation with state governments, on a "dollar for dollar" sharing basis.[68] This plan would encourage the investment and participation of local populations in the project, as states would have a vested interest in promoting the project locally – but that deference to the states would mean that the project would be reliant on state financial support to reach completion, and therefore uniform project support would not be guaranteed across state lines. The final option that the report presented was for the federal government to work not only with the states, but also to work directly with local landowners. Rather than

purchasing the land at the federal or state level, the government could work with existing land owners to plant on land they did not otherwise own. It is noted by the report author that this plan could be enabled by the already-existing Clark-McNary Law, Section 4, but would require an increased appropriations budget from Congress, and might "sharply limit the possibilities of prompt and complete fulfillment of the work."[69] Without full control of the land the belt would be planted on, the government would not be able to ensure uniformity across the project itself. Finally, the report appealed to the value of the Shelterbelt to people:

"A larger and more vital value, however, and one that cannot be expressed in physical terms of realized by those who have not experienced life in the prairie-plains region, is that 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."[70]

Roosevelt wrote back to Stuart within days, asking what it might cost to put six belts, five miles apart, on just the western side of what had been deemed the potential "central belt": portions of north and west Texas, western Oklahoma, western Kansas, and central Nebraska. Roosevelt also wrote inquiries to the Forest Service, asking about the possibilities of using Forest Service nurseries to create "a definite enlargement of desert land planting," and to see if there were low-cost options within the federal government that he might be able to utilize.[71]

In return, Edward Sherman, Acting Forester of the Forest Service, wrote to Roosevelt detailing potential planting conditions around Roosevelt's specification, which he estimated would stretch from Childress, Texas to Valentine, Nebraska. He noted that conditions for planting were generally worse in the south than the north, and that the

ground should ideally be prepared a year in advance, with continued cultivation for up to ten years. If they were to follow Roosevelt's idea of planting six enormous strips of trees (100 feet each) over the 600 miles between Childress and Valentine, Sherman estimated that the project would require 43,635 acres of planting land in total, with a total cost of just under two million dollars for planting, labor, and cultivation. Sherman estimated that acquiring the necessary private land to carry out the project would raise the cost to $2.7 million dollars, with another $2.3 million dollars in fencing costs.

To reduce costs, the report proposed changing the six 100-foot strips of plantings to just one strip, 600 feet in width. This would greatly reduce the fencing costs, taking the estimated project cost down from $115 per acre to $71 per acre. Another option would be to work cooperatively with existing land owners in the planting area to secure an equal amount of acreage in non-contiguous areas. He wrote "it is quite possible that by a cooperative method it would be unnecessary to acquire any land, labor costs for planting and cultivating might be reduced 50 per cent, and fencing costs reduced to costs of materials only, thereby reducing the final average costs per acre to $37.50." Under this method, Sherman estimated that the total cost of the project might be only $1.6 million. By the next month, September of 1933, Roosevelt directed Wallace to discuss the issue with the Forest Service and determine if they would it feel it worthwhile to pursue such a shelterbelt project, if they were to have a budget of $1,000,000 per year. Roosevelt specified that he would prefer to use privately owned land that could be donated by land owners.

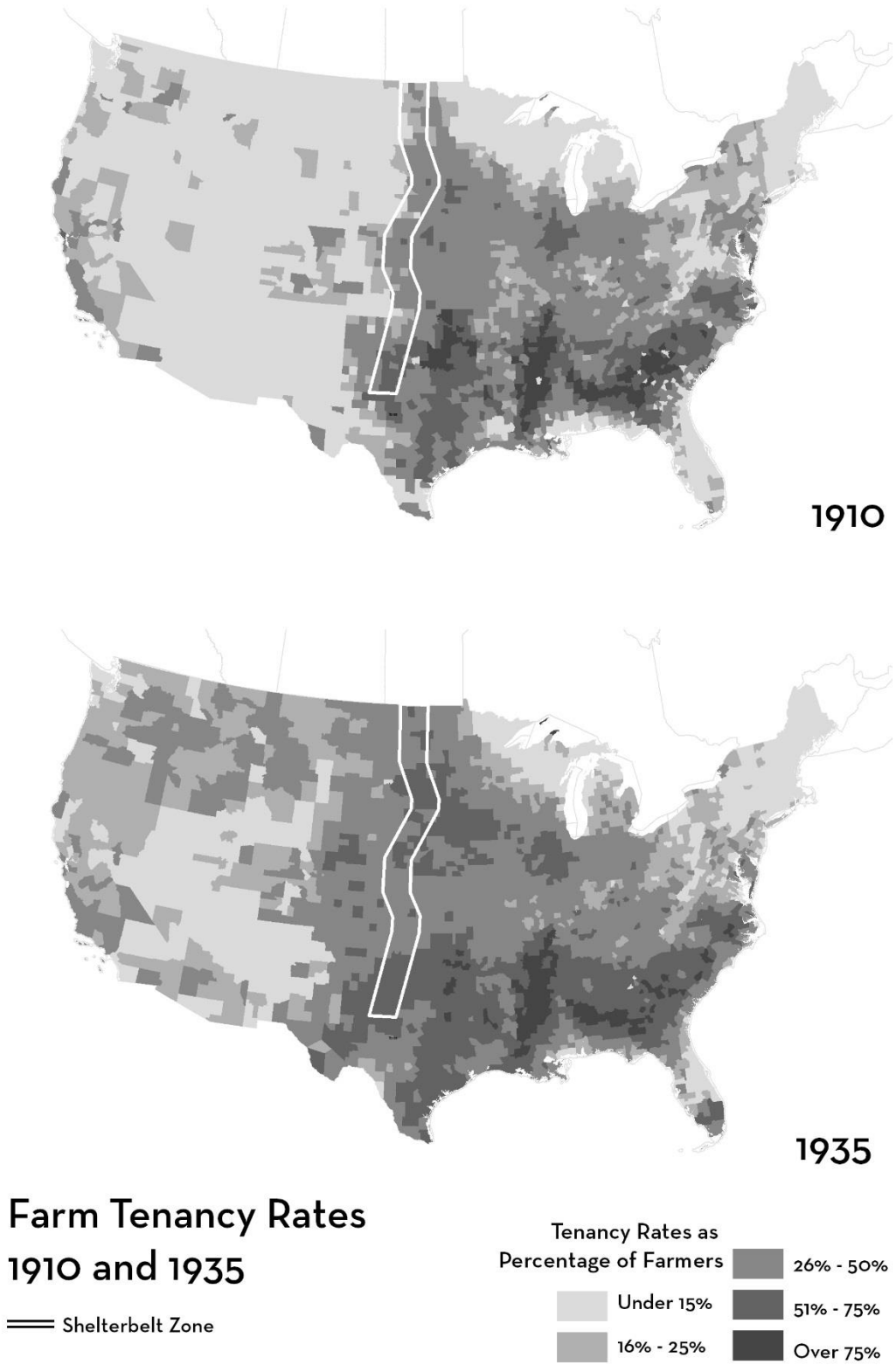


Figure 6: "Farm Tenancy Rates, 1910 and 1935"[72]

Chapter 2: Zon's Radical Ecological Forestry

"A small bunch of foresters cannot buck the march of economic events… We can be a thousand times right, but our voice will not prevail… I cannot see how we can put over regulation of the lumber industry – the only thing I am convinced will stop forest devastation."

Raphael Zon to George Ahern, 1929[73]

Introduction

Forestry in the United States underwent political shifts in the early 20th century as the new profession found it footing. Early debates between foresters about whether the field should focus on ecological forestry or technical forest management expanded into debates about the scale, manner of control, and regulation over forest land. Gifford Pinchot and Raphael Zon advocated for public control of forest lands and increased federal regulation to slow forest devastation and clear-cutting of forest lands. On the other side of the debate were those interested in technical forest management who aligned with private control and development of timber stands and a market-driven view of forestry. After his appointment as the nation's first Chief of the Forest Service in 1908, Pinchot found himself at odds with the Taft administration over private development in forests beginning in 1909, a disagreement that ultimately lead to his dismissal.

Forestry under the Harding, Coolidge, and Hoover administrations ushered in an era of New Conservatism that began after World War I, giving priority to the lumber industry as a primary driver of US forest policy. The 1924 Clarke-McNary act continued this trend by concentrating forest control at the state level and advocating for state cooperation with private interests. In response, foresters such as Pinchot and Zon continued their fight for increased forest regulation and public ownership of forest land. By 1930, there were such large divisions among foresters that even the *Journal of*

Forestry became contentious, with Zon and his colleagues engaged in a fight against the editorial board of the *Journal of Forestry* to see a greater emphasis put on public service in what they saw as their profession's most important scientific journal. Many of the foresters in leadership roles at the Society of American Foresters believed that forestry should be limited to improving forest management techniques and aiding the forest industry and that properly conducted science was inherently apolitical. Foresters such as Zon and Pinchot argued that forestry should define itself as a holistic and interrelational ecological science and believed that foresters had a role to play in politics and national policy debates. As the Roosevelt administration came into power, many in Zon's group found themselves well-positioned politically to finally enact their case for public ownership and regulation through New Deal policies.

Zon's Relational Section of Silvics

In 1906, Pinchot established the Section of Silvics within the Forest Service to facilitate research and data collection while sectioning off forest engineering and forest management to the Office of Forest Products.[74] The following year, Pinchot appointed Raphael Zon to lead it. Having joined the Bureau of Forestry in 1901 after his graduation from the Cornell School of Forestry, Zon and Pinchot would go on to become lifelong friends, with Pinchot describing Zon's "encyclopedic knowledge of facts both in the literature of forestry and the woods" as "preeminent."[75] Pinchot's selection of Zon to head the Section of Silvics was reflective of Pinchot's support for Zon's ecological view of forestry and during a time when biologists were reassessing the value of field-based research.[76]

Zon's understanding of biology and his views on the role of politics in science was forged in his early life. Born in Simbirsk, Russia, in 1874, Zon was raised in an environment of "leftist intellectual politicization" and attended the same secondary school as Vladimir Lenin and Alexander Kerensky.[77] Zon agitated for representative government during his early life Russia and had direct involvement in attempts to create early Russian trade unions.[78] He went on to attend the Imperial University of Kazan, where he studied comparative embryology, then left Russia for Italy, where he worked at the Stazione Zoologica in Naples. At the time of Zon's work in Naples, the Stazione Zoologica was one of the leading centers in the world for embryology, having been founded in an effort to provide research space away from tradition-bound research departments inside universities.[79] Stazione Zoologica was founded in 1872 by German Darwinist Anton Dohrn, who envisioned a site next to the sea where marine biologists could conduct their work with ready access to research materials and laboratories.

After a short time in Naples, Zon was called back to Russia for sentencing in response to his illegal trade union organizing. In Russia, Zon was sentenced to an eleven-year jail sentence in a Siberian prison,[80] but he was able to escape Russia with the help of friend Aleksei Aladin, founder of Russia's Trudoviks Peasants Party.[81] After leaving Russia, Zon traveled first to Germany and then went on to Belgium, where he attended the University of Liege. He then moved to London for a year, where he quickly became friends with many in the leftist intellectual elite through his social activities with the Fabian Society. London's Fabian Society impressed upon him the idea that science was inherently political and helped merge together his political experience in Russia with the scientific training he had received in Kazan and Naples. After a decision to leave

London for the United States, Zon arrived in New York City without work or money. He found temporary work at a drugstore to make ends meet. Wanting more for himself, in 1899 he made his way to Ithaca, New York, to study forestry at Cornell University.[82]

The year 1899 turned out to be a watershed year for ecological science, as both geographer William Morris Davis and botanist Henry C. Cowles published works focusing on dynamic and changing landscapes. William Morris Davis published "The Geographic Cycle" in *The Geographical Journal* in November of 1899 when Davis was a professor of physical geography at Harvard University. In the article, Davis asserts that all landforms are the functions of structure, process, and time and that geographers must look past what is "ready-made" and push for a rational explanation for the creation of the earth's features. Understanding where geographic features are located is "only the beginning of exploration, which has no end till all the facts of observation are carried forward to explanation," he argued.[83] Davis' geographical cycle traced what he believed was the linear evolution of land forms through an ordered process, beginning with surface uplift and culminating in what he termed "old age," which was reached when hilltops and valley floors became graded and no new features were developed.[84] Davis' dynamic view of landscapes was pushed back against traditional understandings of the earth as static, many of which were based in creationism.[85] This focus on evolution, as applied to landscapes or structures that were not themselves discrete biological organisms, became known as the *organismal metaphor* in geography.

Henry C. Cowles applied the organismal metaphor to botany during the same time Davis was completing his work on the geographical cycle, producing an article on plant succession that was published just a few months before Davis' (Cowles work was

published in February, with Davis' appearing in November). Cowles conducted field studies of sand dunes in Indiana and the eastern shore of Lake Michigan from 1897-1899, resulting in the publication of a vegetation cycle which purported to explain plant succession for dune species. Cowles positioned himself as an ecologist who employed physiographic methods, but, unlike a traditional physiographer, "regard[ed] the flora of a pond or a swamp or hillside not as a changeless landscape feature, but rather as a panorama, never twice alike," claiming ecology as "a study in dynamics."[86] Cowles' positioning of ecologists as scientists who focused on the dynamism and interrelationships of species was the beginning of an academic argument that would echo through other fields as well, including American forestry.

Davis' work was picked up by Frederic Clements, an ecologist who obtained a doctorate in botany from the University of Nebraska in 1898, right before Clowes and Davis published their breakthrough work. Clements was heavily influenced[87] by Davis' writings, and produced a theory of vegetation dynamics that was more broadly applicable than Cowles' work. In 1916, Clements published the book *Plant Succession: An Analysis of the Development of Vegetation* as a professor at the University of Minnesota. The book was published by the Carnegie Institution of Washington. Picking up on the use of organismal metaphor, Clements argued that entire communities evolve over time in specific ways, developing over time along predictable paths. These paths of development culminate in stable and foreseeable endpoints, which he termed climaxes. Clements viewed the world as being comprised of distinct spatial entities terms "communities," with the climate of each community existing as a function of balanced vegetation. Each community was bordered on the edges by "ecotones," which served as the boundary

between communities. Though there were differences among communities, each community could be expected to experience plant or climatic succession in an orderly way, working its way to what he termed a "climax." A climax community was a community that had successfully completed all stages of succession and reached its ideal balance. Climax communities were static and stable, with links among species existing specifically for the benefit of the entire community.[88] Thus, for Clement, if a disruptive event occurred on the land that altered the pre-existing order of things, the association of plant species would naturally work towards a return to its former climax state. Clements' views followed the work of Jean-Baptiste Lamarck, who saw evolution as nature's inherent trend toward perfection.[89]

It was in this scientific moment that Zon enrolled as a member of the first graduating class of the New York State College of Forestry at Cornell University, where he encountered and documented underfunded departments, busy faculty members who spoke badly of their peers during courses, and low-quality student housing and food.[90] The philosophy of the New York State College of Forestry at Cornell University was centered on a hands-on approach to learning, and assignments for forestry students included such tasks as surveying and mapping forty acres by hand.[91] After graduating, Zon moved to Washington, DC, and took a post with the US Bureau of Forestry. It was at the Bureau of Forestry that Zon first met Pinchot, who would become a life-long friend. Pinchot later described Zon's journey to Washington as occurring in a time when there was a strong need for cultivating a public appreciation for forests such that it could "result in saving some of it," but also a need for strong foundational science to "make each advancing step secure." Pinchot credited Zon with furnishing "the scientific

foundation upon which a great public movement rested safely during the critical early stages of its growth."[92]

Zon began to quickly move up the ranks at the Bureau of Forestry, starting as a student assistant, moving up to Assistant Forest Expert, and, by 1904, was a Forest Assistant. By 1905, he was on the editorial board of the *Forestry Quarterly* and edited the *Proceedings of the Society of American Foresters*.[93] Zon held an ecological view of forest research that focused on forest dynamics and interrelationships that broke with what many understood as traditional forest management, and as a result, felt frustration in his early years with the Bureau of Forestry, seeing that the Bureau often ignored or failed to properly implement many of the German methods of forestry he learned from Fernow at Cornell.[94] In a 1904 memo to Pinchot, Zon began agitating for the creation of a Section of Silvics, arguing that "in the present state of our scattered silvical knowledge there cannot be any continuity in our silvical work."[95] Zon wanted to organize the Forest Service's research data, but he also wanted to carry out research in a way that was systematic, thought-out, and centrally organized. His solution was to carry out research through permanent forest experiment stations.

The Fremont and Alpine Laboratory

Zon's push for ecological forestry was demonstrated by his commitment to both forest research and a desire to be forward-thinking about research sites and methods. After achieving his goal of running the Office of Silvics, Zon continued to push forward with the creation of a twenty-three-page plan for creating Forest Experiment Stations. Zon's Forest Experiment Stations were the key to his larger plan for organizing federal forest research, as they would function as embedded sites of ecological forest research.

Forest Experiment Stations would allow researchers direct access to the forest while providing them with necessary resources and materials for serious study. Part of Zon's inspiration for his Forest Experiment Stations was the recent development of the Carnegie Desert Laboratory, which did much to not only provide physical sites for ecological research, but made an effort to drive the research agenda itself.[96] Zon's memo laid the groundwork for the establishment of the very first forestry experiment station in the Coconino National Forest in Fort Valley, Arizona, a site chosen by Zon himself.

In 1908, Pinchot mentioned Zon's plan for Forest Experiment Stations to Fredric Clements after running into him in St. Paul, Minnesota, where Clements was working as a professor at the University of Minnesota. Clements had previously helped establish the Alpine Laboratory in 1900, a site in Colorado's Pike National Forest that served as a summer research location and which made possible the studies that brought Clements to prominence.[97] After learning of Pinchot's plan with Zon to establish Forest Experiment Stations, Clements extended an offer to Pinchot for Zon to visit and see the Alpine Laboratory in action. Zon accepted the offer and his visit to the Alpine Laboratory led to a brief collaboration with Clements.

Clements and Zon conducted a joint study to examine the effects of fire on lodge pole pine trees which was published in 1910, but their relationship was complicated. Zon took issue with Clements' physiological focus in his research, as Zon felt that forest dynamics and interactions were more important than pure plant physiology. In 1908, Zon criticized Clements in published work, arguing against Clements' use of a photometer by saying that "impressions or purely empiric knowledge is insufficient" – a criticism that was meant to carry the weight of Zon's disapproval of Clements' focus on physiology.

As Brock has described, Clements favorited instrumentation that gathered "attributes of the plants and the environment in which they existed," while Zon preferred newer instruments which "were designed specifically to gather information about the dynamic interactions between plants and the environment, the very action of the struggle by which plants survived and thrived."[98] Zon wrote directly to Clements, arguing that all research work should be a process separated out from the Forest Service.[99] Zon's early criticisms of Clements laid the groundwork for a split in forestry that he would come back to over and over again: Zon believed strongly in a holistic ecological approach to forestry that considered the dynamism of interrelationships, while many other foresters focused primarily on measuring plant attributes and improving the technical methods for doing so.

Zon's visit to the Alpine Laboratory also resulted in the establishment of the Forest Service's Fremont Experiment Station in the Pike National Forest. Zon's Fremont Station sat on the opposite side of the same ridge as Clements' Alpine Laboratory. Zon appointed Carlos G. Bates as the first Director for the Fremont Station. Like Clements, Bates was a graduate of the University of Nebraska. Unlike Clements, however, Bates kept his research focused on interactions, and in 1909 published a breakthrough watershed study on the relationship between forests and stream flow. Bates was known as a "maverick" forest scientist with an "independent spirit" who was known for his "keen mind, capabilities, and versatility."[100] Bates had first embarked on employment with the Forest Service in 1907, where he had worked on a windbreak tree planting study out in the Nebraska Sandhills in 1909. He would later go on to become the national Vice

Chairman for the Society of American Foresters and serve as associate editor of the *Journal of Forestry* from 1925 through 1931.[101]

Bates passionately believed in the importance of meticulous scientific research and believed that the Forest Service should run a research branch that would allow for true scientific discovery on its own time frame, completely outside of the Forest Service's usual push for practical research on a fixed timeframe. As Bates wrote, "scientific conclusions cannot be established by any fixed time schedule and that the investigator should be the sole judge as to when conclusions have been arrived at."[102] Zon called Bates "the best embodiment of a truly scientific worker – my ideal to which I myself never fully measure up." The two also often disagreed and debated their work[103] and were both known as "opinionated, hotheaded, and intelligent researchers."[104] However, Zon and Bates both believed that forestry was meant to be a scientific field centered on rigorous and forward-pushing research methods, and Zon carefully staffed his stations with scientists who he felt shared his views on questions of ecological dynamism. Zon's placement of Bates and the Fremont Experiment Station "across the ridge" from Clements at the Alpine Laboratory was no coincidence, but rather an assertion of his scientific point of view in direct challenge to Clements' and a denial of a role for Clements in federal experiment stations.[105]

Zon's debate with Clements was not without practical stakes. Clements' theories of vegetation succession held that species within communities worked together to grow toward, or revert back to, their climax endpoint. For foresters, this idea had huge implications: namely, that forest managers could rely on the predictable patterns of nature to ensure that logged or clear-cut forests would eventually rebound to their climax state

all on their own. From their point of view, forests were predictable and controllable, and it was possible for forests to return to a robust state without necessary intervention. However, Zon did not subscribe to Clements' conception of climax communities. By contrast, Zon felt the science that undergirded the conception of climax communities was fundamentally incorrect, and that focus should be placed on understanding dynamic interrelations that were producing ecological systems. Given this belief, Zon was not at all assured that forests would regenerate on their own, prompting big concerns about the nation's forest inventory and a belief that human intervention was necessary to ensure regrowth. When Zon was in control, he was careful to make sure that federal spending was always coupled to scientists who belonged to the dynamic and analytical side of the field.[106]

Like other scientists of his day, Zon's work was heavily influenced theories of evolution. In addition to Darwin, who Zon credited with giving the "flesh and blood"[107] to the idea of natural selection, Zon was interested in re-centering the history of evolutionary theory and "restor[ing] the memory" of forester Patrick Matthew. Matthew proposed a theory of natural selection earlier than Darwin did after observing stands of naval timber and extrapolating out his observations to nature as a whole. Zon believed that forest was a prime object of study for understanding natural selection and the struggle for existence, especially given that forests were involved in dynamic relationships. "Forestry as an art is nothing else but the controlling and regulating of the struggle for existence for the practical ends of man," he wrote. "Forestry as a science is nothing else but the study of the laws which govern the struggle for existence...in this lies the strength of forestry, its peculiar beauty, and the debt which sciences owes to it." Zon

believed that forestry was much more than a management system that could work for the good of the timber industry – he saw it as not just a legitimate science, but a strain of science that should use its unique contributions to push forward and lead science in new directions. Zon also hoped that forestry could serve the development of the country rather than just the interests of the white-collar classes.[108] He saw it as a social responsibility that forests and public lands should serve the interests of the nation's citizens. Unlike John Muir's sense of conservation based on the ideas of 'unspoiled land,' Zon did not necessarily reject a commodity view of nature. He was realistic about what he saw as the economic basis of forestry, and worried that forestry as a profession was heading down a path that was more of a trade union than "a professional society for the defense of the public good."[109]

Gifford Pinchot and the Taft Administration

Gifford Pinchot was appointed as the first head of the United States Forest Service in 1908 at the end of President Theodore Roosevelt's time in office. In early 1909, however, newly-elected President William H. Taft began serving his term. President Taft preliminarily retained James Wilson as the Secretary of Agriculture, and Wilson kept Pinchot in his position as the head of the Forest Service. Prior to the end of his term, Roosevelt personally requested that Taft keep James Garfield, an ally to Pinchot and conservation practices more generally, in his role as the Secretary of the Interior, and Taft agreed. By late January, however, Taft changed course and decided to remove Garfield from his position. Shortly thereafter, Richard Ballinger, previously the Commissioner of the General Land Office, accepted Taft's appointment to become the new Secretary of the Interior. Ballinger and Pinchot's views on public lands were

divergent: in his role as Commissioner, Ballinger had approved of the out-right sale of public lands to private citizens, while Pinchot was in favor of doing no more than leasing public lands to private citizens, placing an emphasis on retaining public ownership. Pinchot viewed Taft's decision to appoint Ballinger as a "betrayal" of the conservation movement and made moves to protect what he could while Garfield was still in power.[110]

Pinchot was concerned about protecting land in national forests from private development, specifically land that ran along public domain rivers in areas that were likely to become sites for generating electric power. Though it was not yet legal at the time for private individuals to obtain land in national forests for power generation, Pinchot had seen rights given to private individuals for both mining and quarrying and felt it may only be a matter of time before public land along major rivers was lost. Pinchot and Garfield worked together before Garfield's departure to begin withdrawing key sections of land within national parks as "ranger station administrative sites," classifying the land as such to guarantee that it wouldn't be able to be turned over for private development. Upwards of 4 million acres of national forest land was "withdrawn" between December 4, 1908 and the day of Taft's inauguration.[111] Just ten days later, Ballinger began his tenure as Secretary of the Interior and began restoring the entry of Pinchot and Garfield's withdrawn river sites. From Ballinger's perspective, if Congress decided to open public lands up for development in the future, the Secretary of the Interior wouldn't have the power to protect or withdraw any land from their reach, making the withdrawals useless, and he referred to the withdrawals as "illegal" in conversation with the chief engineer of the Reclamation Service.[112] Vigorous protest by

Pinchot in April of 1909 led to a reversal of Taft's opinion on the matter, and Ballinger had to oversee undoing his restoration of the withdrawals.

In 1909, Louis Glavis, an employee of the Department of the Interior, accused Secretary Ballinger of allowing a fraudulent coal claim in Alaska national forests to proceed without proper levels of investigation. After his requests to the Department of Interior fell on deaf ears, Glavis reached out to the Forest Service to intervene in the matter. The Forest Service and General Land Office's history of competition had only strengthened after recent tussles between Pinchot and Ballinger, and so the Forest Service received Glavis' request with some excitement. Secretary of Agriculture Wilson requested a delay of the hearing, and Glavis wired the Forest Service that he had "damaging and conclusive evidence showing official misconduct" of both Ballinger and Commissioner Dennett.[113]

In August of 1909, Ballinger, Pinchot, and Glavis all traveled to Spokane, Washington to attend the National Irrigation Congress. Glavis was able to present Pinchot with the materials he had gathered on Ballinger and Pinchot reviewed them with George Pardee, then Governor of California. Both Pinchot and Pardee found Glavis' material credible. Glavis alleged that as while Ballinger worked at the General Land Office and during his tenure as Secretary of Interior, he allowed land with rich coal deposits at the head of the Bering River to be sold into private ownership, when they should have been retained for the strategic interests of the country. At the same conference, Pinchot received a tip from a reporter that 15,800 acres of valuable power development sites had just been purchased by private developers in the short period between withdrawing, restoring, and again-withdrawing the river sites.[114] Upset by the

combination of news, Pinchot's speech the next day at the Irrigation Congress was forcefully critical of those who used legal constructions to favor special interests over the needs of the people. Though Pinchot did not call-out Ballinger by name, crowds in the West understood Pinchot's insinuations and a clear divide began to form between Pinchot and Ballinger's supporters.

On August 18, 1909, while Pinchot was still traveling out West, Glavis went to Washington, DC and had the opportunity to present his allegations about Ballinger to Taft directly. Shortly thereafter, Pinchot received a letter from Taft stating that Glavis had been dismissed. Taft's letter to Pinchot urged calm and Taft pledged assurances to Pinchot that he would retain conservation policies. "I should consider it one of the greatest losses that my administration could sustain if you were to leave it, and I sincerely hope that you will not think my action…is reason for your taking a step of this character," Taft wrote.[115] Later that day, Senator Dolliver of Iowa, a Pinchot ally, read a defense of the Forest Service on the floor of Congress that attacked both Ballinger and Taft. Believing Pinchot was the root cause of Senator Dolliver's insubordination, Taft fired Pinchot as Chief of the Forest Service.

Graves, Forest Streams, and the 1911 Weeks Act

Pinchot was replaced by Henry Graves, the first dean of the Yale School of Forestry. Under Grave's command, the Forest Service greatly expanded its forest eastern holdings through the passage of the 1911 Weeks Act, which was first introduced to Congress on July 23, 1909, right before Pinchot's departure. Expanding existing eastern forests had long proved a difficult task to accomplish, with Congress rejecting more than 40 bills between 1901 and 1910 that would have helped establish eastern forests.[116] The

Forest Service did not have constitutional authority to purchase private land to expand its holdings, making it dependent on Congress to increase the amount of forest land under its control. Legislators against expanding forests preferred that forest land be managed at the state level, an issue that blocked forest advocates time and again from being able to expand federal forest lands and left forest protection largely up to the states.

The role of forestation in determining streamflow was hotly debated at the time, particularly in light of damaging floods that many conservation foresters were concerned may have been exacerbated by clear-cutting and deforestation. In 1907 alone, a major flood of the Monongahela River caused as much as $100 million dollars in damage after devastating sections of West Virginia and reaching as far as Pittsburgh.[117] Scientific research on the subject was still in beginning stages and would continue over the next decade, with Zon and Bates at the helm. Zon was the author of a report attached to the 1912 Proceedings of the National Waterways Commission entitled "Forests and Water in the Light of Scientific Investigation" that argued that forests had the capacity to lessen the effects of flooding, noting that "so many are the factors which play related parts in this influence, and so wide the range of economic interests affected, that considerable divergence of opinion has arisen on the subject."[118] Meanwhile, Bates began work in 1910 on the Wagon Wheel Gap Streamflow experiment, a Forest Service effort to calculate the effect of forest cover on snow melt, streamflow, and erosion that would run for more than a decade in length.[119]

Representative John Weeks, a banker and a Republican, was a surprising choice to sponsor Congressional legislation for the protection of forestland, but having grown up near New England's White Mountains, he took a personal interest in the issue. His

position as a businessman carried weight with the Speaker of the House, allowing for potential traction in the House of Representatives. Weeks' first legislative attempt was known as the Appalachian and White Mountain National Forests bill, which died in 1908 after the House Judiciary Committee declared the bill unconstitutional on the grounds that federal money could not be spent from the treasury unless there was a clear constitutional authority under which money could be appropriated. In order to solve this issue, the 1910 Weeks Act utilized a commerce clause in the United States Constitution to justify purchasing private forest land at the head of navigable rivers to protect American waterways for commerce. This would allow the Forest Service to greatly increase the amount of eastern forestland under Forest Service control. The House of Representatives passed Weeks' bill in June of 1910, with the Senate following in February of 1911.[120]

The Weeks Act gave each state the authority to enter into agreements with other states for forest land conservation or water supply conservation. It also gave the Secretary of Agriculture up to $200,000 to work states to help preserve forested watersheds around navigable streams with fire protection costs. It also authorized the Secretary of Agriculture to work with states to create a system for fire protection on private or state forest land along navigable rivers and to protect private forest lands in the watersheds of navigable streams, leaving the private owner to only remove timber from the land subject to forest regulations. Critically, it granted the Secretary of Agriculture $1,000,000 in the first year and up to $2,000,000 in subsequent years through 1915 for the out-right purchase of private forest land that was located at the head of any navigable river. The Act also established the National Forest Reservation Commission, a body

consisting of the Secretary of War, Secretary of the Interior, Secretary of Agriculture, two members of the Senate as selected by the President of the Senate, and two members of the House of Representatives as selected by the Speaker of the House. The National Forest Reservation Commission was authorized to consider lands recommended for purchase and determine purchase price. The Secretary of Agriculture was to recommend land for purchase and give his recommendations in formal report to the Commission. Any purchases made by the Commission would require examination by the United States Geological Survey, with a report demonstrating that federal control of the lands would contribute to the protection of the navigable waterway.[121] It also allowed the federal government to contribute to state-level fire suppression efforts on the condition that states do so at federal standards and required that a percentage of revenue from national forests be directed to the states to fund roads and schools in counties where national forests were located.

Under the Weeks Act, the Forest Service was able to acquire swaths of land in the eastern United States that had been clear-cut by private development and abandoned at high rates. Land purchased under the Weeks Act would ultimately amount to twenty-four million acres of protected forest land.[122] Up until this point, national forest land had only been designated out of already-existing public domain land, as the federal government did not have constitutional authority to purchase private land to expand its forest holdings. The Weeks Act was only able to pass through Congress due to an amendment that specified that land purchases were to maintain stream navigability, viable under the commerce clause due to the use of streams for commercial shipping and navigation.[123]

Post-War New Conservationism and the Clark McNary Act

Following World War I and the end of the Wilson administration, the executive branch shifted back to Republican control for twelve years under Harding (1921-1923), Coolidge (1923-1929), and Hoover (1929-1933). As Republican administrations exercised power through the executive branch, the Forest Service tracked toward helping businesses, particularly under the tenure of William B. Greeley, who served as Chief of the Forest Service from 1920 until 1928. A 1904 graduate of the Yale Forestry School, Greeley believed in working in direct cooperation with large timber companies. Under all three Republican administrations, public lands continually fell into private hands, frustrating foresters who believed forestry had a bigger role to play in scientific research than merely advancing the interests of lumber companies.[124]

In 1919, Henry Graves began to push more heavily for the idea of public regulation of private forest land. He suggested that the federal government could provide state funding to protect private holdings from fire in exchange for public forest regulation at the federal level, something he deemed critical given that the vast majority of timber in the United States was held on private lands. Royal S. Kellogg, a former colleague of Graves' in the Forest Service, pushed back against the idea, advocating instead for increasing the public funding for fire protection and purchasing already-cut land from private owners.[125]

In 1924, the Clark-McNary Act was passed, which expanded upon the 1911 Weeks Act. The Weeks Act had enlarged the National Forest System through land purchases, resulting in more than two million acres of land purchased for the National Forest System by 1920. The Clark-McNary Act made it even easier for the federal

government to purchase land, as it allowed for the purchase of land to protect entire watersheds, not just streams. It also allowed for cooperative efforts between the farmers and the government to help produce and distribute tree plantings. It encouraged cooperation of the federal government and state-level officials on issues such as fire control and timber production, making it advantageous for each state to have their own forest agency. The Forest Service under Greeley viewed the Clarke-McNary Act as a stop-gap against "radical schemes" to regulate private industry at the federal level by enshrining into law the idea of voluntary, not mandatory, cooperation between government and private industry which was scaled to state, and not federal, control.[126]

The conservatism of the early 1920s left Zon as a political aberration within the Forest Service. Combined with a new role as the head of the Lake States Forest Experiment Station in Minnesota, Zon became somewhat removed from being able to exercise direct power within the larger field of forestry.[127] Zon did what he could to shape the field through his editorial work, becoming the full editor of the *Journal of Forestry* in 1923 when Fernow stepped down, a position he would hold until 1928. He had previously served on the *Forestry Quarterly*'s Board of Editors from 1905 through 1916 and had served as a managing editor from 1917 until his appointment as full editor in 1923. Zon's editorials in the *Journal of Forestry* helped establish a more rigorous approach to forestry education. Zon took issue with the inadequate quality of many forestry teaching personnel, among other items, and his criticisms led to the accreditation of forestry programs by the Society of American Foresters.[128] Zon also utilized the editorial space in the journal to advocate for an ecological approach to forestry. In a *Journal of Forestry* editorial from 1926, Zon laid out his concerns for the future of forest

research, questioning "whether our task is to apply the scientific results of others to our specific problems or whether we can develop our own scientific methods and a science of forestry."[129] Zon had long advocated that forestry was as legitimate a science as other specializations and felt forest science should never be left in the hands of professionals from other fields, arguing that "foresters must become leaders in forest research and not depend on other scientific groups to work out the fundamentals."[130]

Meanwhile, a January 1929 letter from young forester Bob Marshall to Zon's friend forester Col. George Ahern on the topic of Ahern's recently published book *Deforested America* became the genesis of a new fight for federal control. Writing in appreciation of Ahern's ideals which were laid out in the book, Marshall noted that

> *"…a dynamic new organization composed exclusively of those who favor vigorous government control seems imperative. I would hesitate to write about this matter, appreciating fully that you and Mr. Pinchot do not require my kickshaw advice, were it not for the fact that such a new organization will need money immediately, and due to certain accidental influential connections, I think that I might be able to help raise some of it."*[131]

Marshall had spent time working at the Wind River Experiment Station in Stabler, Washington in what is today the Gifford Pinchot National Forest, and his views on forestry closely mirrored Ahern's and Zon's. Marshall's letter was passed from Ahern to his friends, and sparked meetings between Marshall and Pinchot at his home in the District of Columbia alongside peer foresters who shared the goal of slowing forest destruction through the regulation of forestland.

A Radical "Letter to Foresters"

After the stock market crash of 1929, the Hoover administration began dismantling forest reserves, arguing that clear-cutting forests provided jobs necessary for

the floundering economy.[132] Alarmed by the actions of the Hoover administration but also attitudes within the forestry community more broadly, Gifford Pinchot, then-Governor of Pennsylvania, assembled an emergency meeting. Pinchot's meeting was held at his home in Washington, DC in January of 1930. On the guest list was Raphael Zon, Bob Marshall, Ward Shepard, and George Ahern. Together, these "politically radical and ecologically inclined"[133] men formed a "coterie of radical foresters." Zon served as the group's "intellectual heart"[134] – his personal relationships with the intellectual giants of forestry continued to give him weight in the field of forestry, despite the manner in which his continued work at the Lakes States Forest Experiment Station Minnesota left him removed from the power center of Washington. Bob Marshall's youth and energy injected new life into the group of longtime colleagues, inspiring them to take direct action. One of the main topics of conversation for the group was a recent report published by the Society of American Foresters which, in Pinchot's view, was dangerously "wishy-washy" in its defense of forest preservation, instead making a case for opening up public lands.[135]

Together, Pinchot, Zon, and their colleagues decided that a letter should be distributed which expressed their contrasting views on the importance of social consciousness within forest ownership and management. Zon is said to have been the main intellectual contributor to the document, but, worried about the dangers of further maligning his own career, he took a backseat to Marshall publicly.[136] The letter urged foresters to embrace forest regulation to stop the destruction of American forests, arguing that it would be a "moral tragedy" if American forests "by silence condone[d]" forest devastation.[137]

The letter framed forestry as a profession of "born with high ideals" and the protection of public forests as a duty to country for all foresters, first and foremost. "The duty of the foresters of America, with faith in the forest and in the Nation, is clear before them. It is to destroy forest destruction in the United States."[138] The letter argued that American forests were as much of a public resource as railroads and public utilities and that they ought to be federally regulated to the same degree. It also came out against management of forests at the state level, arguing that federal regulations for forests were necessary. "A great nation can and must invoke the powers necessary to save itself from the disaster of forest mitigation," the authors argued, pinpointing the need for forest regulation at a national level to not "rely on independent action by forty or more states in time to save our forests."[139] Beyond their call for federal regulation of forests, Zon's group also issued a call for the expansion of existing public forest land. They argued that the system of private ownership of forest land was failing as "private cut-over lands are being abandoned at an immense scale…the breakdown of private ownership is creating a new public domain."[140] The authors argued that abandoned private lands should be publicly claimed and managed.

The "Letter to Foresters" issued seven principles which the authors argued should form the bedrock of forestry in America. Among these principles were two particularly key beliefs: that forest devastation "cannot and will not be stopped by voluntary effort of forest owners and industries" and that "the only way to stop forest devastation is by public control."[141] These principles alone set Zon's group to the far left of much of the mainstream forestry community, particularly those foresters who were employed by or part of the lumber industry. The "Letter to Foresters" was dated February 7, 1930 and

was signed by George Ahern, Robert Marshall, E.N. Munns, Gifford Pinchot, Ward Shepard, W.N. Sparhawk, and Raphael Zon.[142] The letter was mailed to the private member list of the Society of American Foresters before ultimately being published in the *Journal of Forestry*. Marshall would later describe the letter as "the most radical action any forestry organization had ever taken."[143]

Even before its printing in the *Journal*, the response to the Letter among foresters arrived quickly. Within just two weeks of it being sent out, Zon declared that the letter had gotten "under the skin of our colleagues" in a letter to fellow signer Ward Shepard.[144] The response did not dampen Zon's convictions. "No, it was not in a flippant mood that I signed the 'Letter to Foresters,' he wrote to W.H. Kenety of the Northwest Paper Company. Zon compared forest regulation to the work of the Federal Farm Board, arguing that the creation of a Federal Forest Board could work with trade organizations and owners to control timber production, providing them with credit and fire insurance in exchange for the regulation of forest land. "This is a very reasonable public request for the benefits which the lumber industry is getting," Zon wrote.[145] Zon believed that new outlets for surplus labor and capital were required in place of overproduction and increased mechanization.[146] As Zon wrote in 1931, "we went through this continent as an invading army, pitched our tents, built our Main Streets just long enough to skim the cream and waste the rest…we have depleted most of the fertility of our soils and allowed it to be washed away."[147] Zon called conservation "a fight against the domination of natural resources by private capital,"[148] and always kept his scientific forest research hand in hand with an awareness and empathy for the material effect or potential that his forest work could have on human lives.

Responses to the letter were published in the *Journal of Forestry*'s April issue, where pushback came from four foresters: R.C. Hall, Royal S. Kellogg, Franklin W. Reed, and C. Stowell Smith. Hall, Kellogg, and Reed all pushed back against the principles espoused in the Letter to Foresters by arguing that the ideas Zon's group put forth were mere political propaganda. Hall described the Letter as reading "more like a call to arms than a discussion of principles,"[149] adding that forest policy should be "considered not in the heat of emotion and professional pride, but in the light of facts and sound reasoning."[150]

The critics further compared the principles laid out in the Letter to religious belief, arguing that scientific journals such as the *Journal of Forestry* should focus on promoting scientific research and discussion only. Hall suggested that Zon's group was motivated not simply by a desire to stop forest destruction but to force their political terms on the forestry community. Referring to the letter writers as "fundamentalists," Hall argued that Zon and his fellow foresters "identify the only true religion with their own particular creed… [they] want us to work blindly for production regardless of prospective markets."[151] Reed asked if the forestry profession had become "a priesthood whose members may study and work to support the prescribed doctrine of faith, but who may not use their increasing knowledge nor their better understanding of the facts to modify their previous point of view."[152]

By dismissing Zon's group as political and of fevered belief, critics of the letter argued that there was no place in science for political opinion. Furthermore, the definition of what was "political" for these critics is key. The needs of private foresters and those employed in the lumber industry are not seen as political, while the principles Zon's group laid out are dismissed as nothing but politics. As Reed argued, "the forester inevitably must

look upon forestry as a business proposition, to be practiced with a due regard for financial profit, rather than a public cause to be striven for with something akin to a religious zeal."[153]

Hall attempted to rebuke Zon's group by arguing that federal regulation of forests would be challenged through the federal court system and that regulations which proved too strict could bankrupt the lumber industry. Hall instead proposed that private owners were in a better position to decide how to control forest production, as they were the only ones in a position to know how to maintain profitability. As the time of publication, Reed was serving as the Executive Secretary of the Society of American Foresters with ties to National Lumber Manufacturer's Association, while Kellogg was the Director for the American Pulp and Paper Association and a "leading figure in the ranks of organized timber capital."[154] Reed previously worked under William L. Hall as an Assistant District Forester for the Eastern National Forest District before becoming District Forester himself from 1918 until 1925. As District Forester, Reed believed that eastern National Forests should become demonstration grounds to help private industry learn how to make intermediate forest yields profitable. Reed wanted to see the Forest Service move toward managing forests as demonstration forests on a model like that of the Department of Agriculture's demonstration farms.[155] In his early career, Kellogg worked for the Forest Service before leaving to serve as Secretary of the Northern Hemlock and Hardwood Association. In 1915, he was appointed the Secretary of the National Lumber Manufacturer's Association.

Groundwork for New Deal Forestry

Despite the growing rifts between Zon's group and members of the Society of American Foresters, the relatively high rank of many of Zon's colleagues positioned

them to be in sphere of influence within government, particularly with the incoming Roosevelt administration. Zon and Bob Marshall continued to hold sway with Pinchot, who had Roosevelt's ear. Additionally, a Congressional investigation of American forestry produced at the dawn of the Roosevelt administration, with Bob Marshall among its authors, would come to serve as a blueprint for New Deal forestry under the Roosevelt administration. In 1932 Senator Royal Copeland of New York requested a Congressional investigation on the state of American forestry. The resulting document was "A National Plan for American Forestry," also informally known as the Copeland Report. The Copeland Report offered an improvement plan for American forests to make sure that the social and economic benefits of forests were maximized. The Copeland Report would later become the Roosevelt administration's starting point for addressing forest issues.

The Copeland Report estimated that forest lands comprised around one third of the country in total, with nearly 500 million acres capable of producing commercial-grade timber and the rest suitable for open woodlands. Woodlands were mostly valued for their use in recreation, watershed protection, scenic preservation, and wildlife conservation. Despite comprising a third of the country, the Copeland Report determined that huge swaths of the nation's forests were already depleted with little or no concern given to making sure attaining new forest growth. Northern and eastern timber stands were particularly depleted.[156] Critically, the Copeland Report asserted that poor economic conditions were a primary driver for the depletion of timber stands, as working people utilized local forests for their own benefit. Furthermore, the developing depletion of timber resources was itself contributing to local poverty as those who needed resources were no longer able to access them, resulting in both depopulation and impoverishment.

The Copeland Report charged private forest owners with failing to properly serve as forest custodians, arguing that it was neither wise nor fair that private owners should be responsible for maintaining a huge public benefit and interest. As a result, the Copeland Report suggested that the federal government increase the amount of publicly-held forest land by at least 223 million acres, with 17% of that land total belonging to the central Midwestern states.[157] Alongside an increase in public forest ownership and increased forest regulation, the Report's authors spent time explaining the administrative structures within the Forest Service. When Henry Wallace, Roosevelt's Secretary of Agriculture, presented the report to Congress, he argued that the Copeland Report was proof that "the laissez faire approach and avowedly plan-less private ownership" approach for forests had failed. The Copeland Report ultimately argued against many of the assumptions that Clarke-McNary Law were grounded in. No longer would the idea of goodwill from private ownership with government fire protection be understood as good forest management.

By the time of the report's publication, Bob Marshall had thoroughly convinced Pinchot, then Governor of Pennsylvania, that public ownership and forestry relief was a vital need, and Pinchot was set on the idea of the nationalization of American forest lands as the best path forward. Pinchot told newly elected President Roosevelt that he should abandon the idea of forest regulation for two reasons: because the vast majority of current timber land owners were suffering financial losses and close to bankruptcy, and because he believed that should those owners regain their wealth, they would again have too-easy access to the controlling the agencies which set regulations.[158] At the time, Roosevelt was interested primarily in pragmatic solutions that could be deployed quickly to stabilize

the country. Rather than keep himself tied to the traditional political views of partisan politics, Roosevelt was willing to try anything experimental that might produce the results he was looking for. Roosevelt called on Pinchot to design a new forest policy. Under previous administrations, the states had been given increasing power, but states were not handling conservation and land use programs effectively, and Roosevelt was prepared to take it back.

Chapter 3: A Scientific Plan

"One of the happiest of all happenings in human affairs is when a great situation needs a man with scope enough to meet it and the man appears. That is what occurred when, in the very nick of time, Raphael Zon took his place and began his work among the pioneers of the modern forest movement in America."

Gifford Pinchot[159]

Introduction

After receiving Roosevelt's request to generate a plan to green the Great American Desert, foresters at the US Forest Service drafted a technical plan which met Roosevelt's needs. Raphael Zon of the US Forest Service was one of the primary foresters responsible for turning Roosevelt's broad vision of foresting the plains into a pragmatic scientific proposal. Zon's conception of the project was heavily influenced by his belief in ecological forestry, leading to a plan that would challenge foresters and geographers.

Working alongside Zon were colleagues Edwards Munns and Carlos G. Bates, both of whom were heavily involved in initial project plans for shelterbelt plantings across the Great Plains. Inaction on the part of the Roosevelt administration after the plan was submitted led Munns and Zon to try kickstarting the project from the ground up, with Zon taking a trip to Washington, DC to draw renewed attention to the proposal. The plan was approved by Roosevelt in 1934, concurrent with Zon's involvement in the creation of the 1934 'Zon Petition,' a strong critique of the Society of American Foresters' editorial board and policies that placed Zon's views at the center of debate and criticism within the forestry community.

Zon's 1934 Petition to the Society of American Foresters was still rippling through the forestry community when Roosevelt's Shelterbelt plans were formally

announced. Geographer Ellsworth Huntington, a climatic determinist, came out quickly and publicly against the project during an address to northeastern foresters, further galvanizing support against the project within forestry. Huntington did not believe that investment should be made in attempting to alter climatic conditions, but rather in redistributing populations away from what he termed 'submarginal climatic zones.'

Munns and Zon Restart the Proposal

By 1934, it was clear within the United States Forest Service that the forestation problem in the Great Plains needed to be "attacked from some new angle."[160] With the Dust Bowl crisis deepening, Munns, who had continued to gather research on a potential planting program, attempted to revive Roosevelt's initial Shelterbelt proposal, but was met with no success. With the plains experiencing continued harsh conditions, Munns found that others in the Forest Service considered the idea of planting trees to be a non-starter. Munns was introduced to Charles Thornthwaite, a geographer who had recently completed his PhD at the University of California Berkeley under the direction of geographer Carl Sauer. At the time, Thornthwaite was working as a Professor at the University of Oklahoma while also working for the Soil Conservation Service. Though he had completed his dissertation on the urban geography of Louisville, Kentucky, Thornthwaite's main research interest after finishing graduate school became climatology. After learning that Munns was gathering all available scientific literature on tree planting for windbreaks, Thornthwaite suggested that all relevant literature to the potential prairie planting program should be gathered together and published.[161]

Looking for additional support, Munns wrote to Zon for advice on how they could restart the proposal. Munns urged Zon to write to Earl Clappe, then Chief of the Forest

Service, to convince him of the need for the program. At the urging of Carlos G. Bates, Zon skipped the letter writing and instead traveled directly to Washington, DC. After a meeting with both Clappe and Silcox, Zon convinced them to meet with Secretary Wallace about the potential project. After receiving Wallace's approval, Silcox made a telephone call directly to the White House and set a meeting for the next morning with President Roosevelt. After meeting with Silcox, Roosevelt approved the project. Just like that, the planting program was back on, and this time, Munns was placed in charge of its development.[162]

According to interviews conducted with Munns by Paul Roberts,[163] Munns based the beginnings of his Shelterbelt plan on three main things: first, he considered Roosevelt's initial vision, looking to meet as much of Roosevelt's plan as he thought was feasible. Second, he looked toward the scientific literature that could speak to the possibility of tree planting on the Plains. And finally, Munns looked toward research produced by the various Bureaus (including the Forest Service) of the Department of Agriculture, particularly the work of Carlos G. Bates, the man who had urged Zon to travel to Washington to help get the Shelterbelt program approved.

A Scientific Plan

The research that Thornthwaite urged Munns to publish eventually would be, in the form of "A Plan for The Permanent Benefit and Protection of the Great Plains Belt through Extensive Windbreak Planting and For Immediate Relief" by Carlos G. Bates, Harold R. Scholz, and Joseph H. Stoeckeler. This plan formed the practical basis for what would become Shelterbelt Project, though the project's final form would ultimately differ in places from this first, concrete proposal.

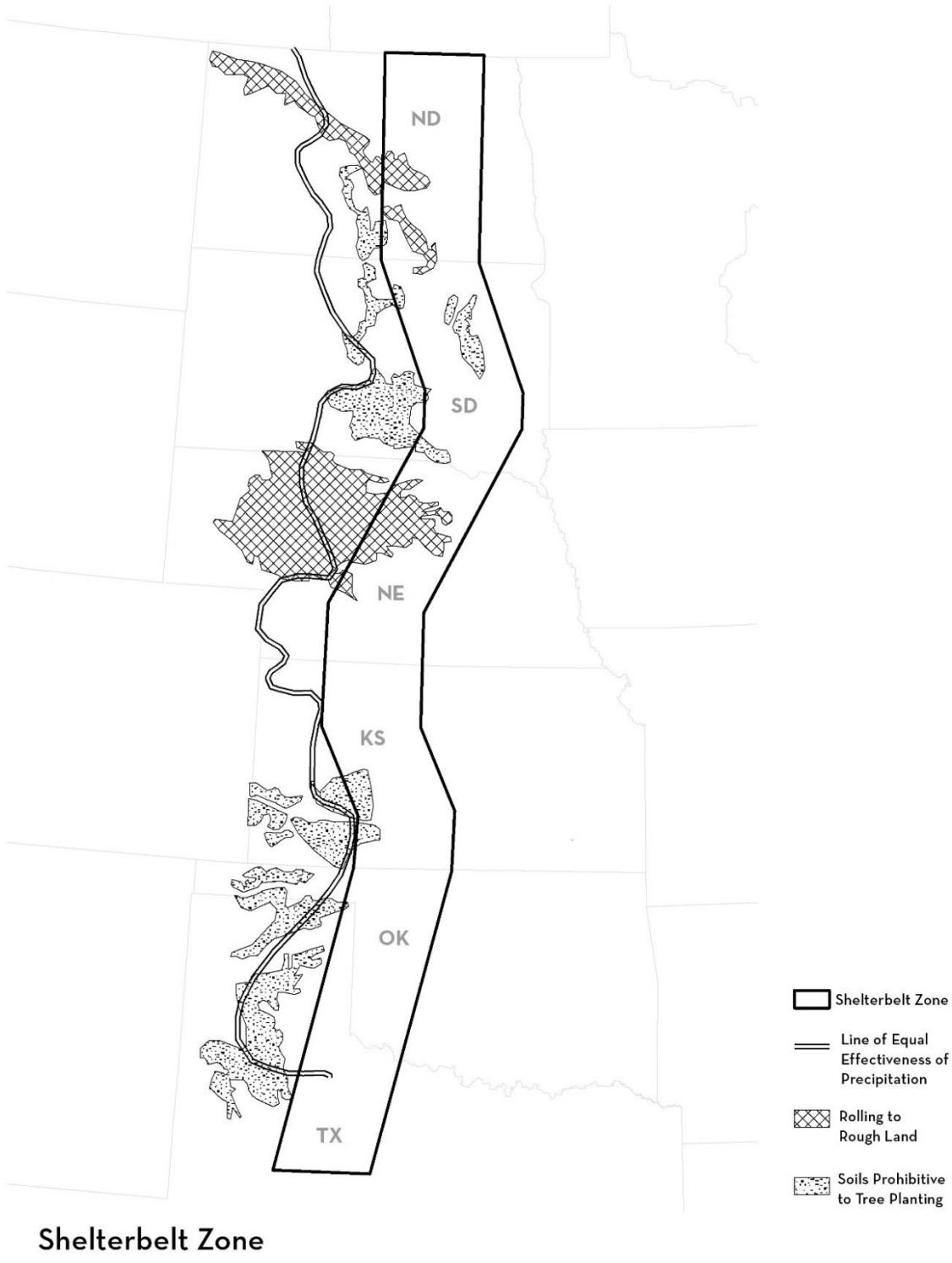


Figure 7: "Zon's Proposed Shelterbelt Zone"[164]

The plan as initially published called for large shelterbelt 100 miles across and 1,300 miles long. The belt would bisect the continental United States by running from the Gulf of Mexico to Canada through North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. An "18-inch rainfall line" calculated by the Forest Service determined the belt's western border, as areas to the west of this rainfall line received such small annual precipitation amounts as to make tree planting difficult. The belt itself was not to be 100 miles of uninterrupted tree plantings, but rather an intricate lacing of 100 parallel windbreaks running north and south along quarter-section lines. Each of these belts would be composed of at least seven trees.[165] All in all, the plan called for nearly 1.8 million acres of belts to be planted. The land was to be purchased outright or leased by the government from land owners for a period of 99 years. The total cost for the project was estimated at $70,980,000, with the authors arguing that an estimated 90% of the project cost going directly to local land owners and to local hired labor, which could be looked at as a form of economic drought relief assistance. The first year of the project would only require 25% of the total budget upfront, with the rest estimated to be dispersed slowly over a period of about ten years.

In connection to the Shelterbelt Project, Silcox approved a new relationship[166] between administration and research divisions within the Forest Service. This came about to protect researchers from taking on the huge administrative complexity of the Shelterbelt Project (including purchasing and leasing land and organizing for fences), while also allowing for the technical aspects of the project to be run by the technical research foresters who understood the complexities of the job. Thus, the technical work, including drawing up blue prints for the technical work, hiring technical men, and technical inspections, were

all given to the Lake States Experiment Station, run by Zon. This allowed for employees of the Experiment Station to move beyond being a mere advisory board and to instead bear the responsibility for all the project's technical plans. Zon believed that if the same blueprint could be expanded across the country to all Experiment Stations, it would aid in "translating the results of research into administrative practice."[167]

On July 11, 1934, President Roosevelt issued Executive Order 6793, "Prescribing the Land Policy, Program, and Procedure in Relation to the Shelterbelt Project" which appropriated funds "for the planting of forest protective strips in the Plains region as a means of ameliorating drought conditions." Zon and his colleagues had been awaiting public announcement of the Executive Order, which had gotten temporarily lost after going through the Department of Justice, Department of State, a return to the White House, and a trip to the West Indies with President Roosevelt.[168] The order set aside $15,000,000 from the $525,000,000 drought relief fund to start work on the project. Wallace granted the Forest Service immediate use of $10,000,000 out of the $15,000,000 authorized. The public was notified via a public press release on July 21, and The New York Times featured a small front-page article about the program on July 22 under the headline "Tree Belt in West to Fight Droughts."

Project Is Announced

In its first announcement, The New York Times described the Shelterbelt Project as "an experiment in climate control to combat the ravages of drought" that was "devised by President Roosevelt himself," and listed the full cost of the program to be $75,000,000 over the course of ten years. Noting just how much of the total budget would get spent on farmers, land purchases, and employment, the article concluded with a discussion on

the long-term protection the Shelterbelt could provide to the Plains region. "Man cannot change all the forces of weather, but he can modify his own surroundings," it states. "He can ameliorate the effects of weather on a large scale, just as he can around his home."

The following week, The New York Times published an even more in-depth article about the project, written by F.A. Silcox, Chief of the Forest Service, under the headline "To Insure Against Drought, A Vast Plan Takes Shape." Silcox wrote that the Plains had become "an incipient desert, threatening not only the dwellers within it but a much larger area to the east" with "social and economic consequences" that are "extremely serious."[169] Silcox described the Shelterbelt Project in detail, explaining that the westward project boundary would be the line of eighteen-inch rainfall, and describing the economic potential of the project as being threefold: an investment in crops, generation of timber for local use, and contributing to the local economy through hiring local workers for planting. Silcox emphasized the transformational potential of the project by stating that though "Man cannot change the cosmic forces of the solar system, but he can modify his own surroundings," citing reforestation efforts in the Karst region, in the South of France, and in Nebraska's very own Sandhills region as "striking examples of the conquest of man over the inimical forces of nature."[170] Praising President Roosevelt for his action, Silcox said that Roosevelt was "plan[ning] through the present for the future: giv[ing] reality to a long-cherished dream – one inspired by the longings of thousands of dwellers in the Great Plains area."[171] As America reacted to Roosevelt's plan, official actions for the project began, the first of which was centering the Lake States Experiment Station in St. Paul, Minnesota as the center for all of the project's scientific research and field investigations.[172]

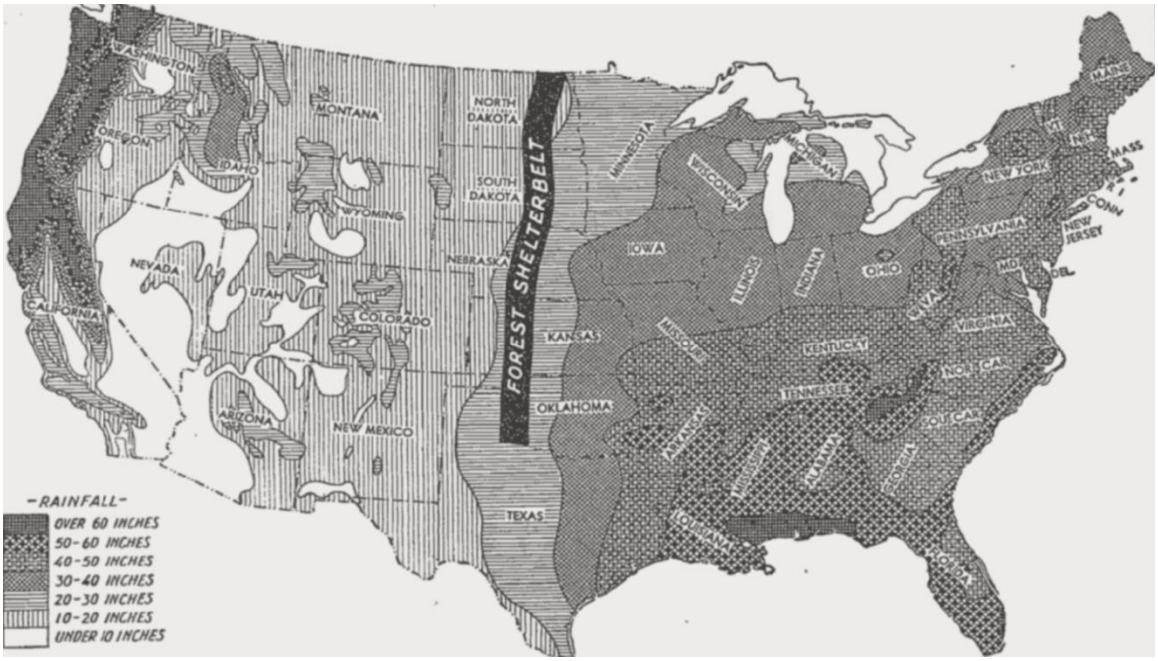


Figure 8: "A Vast Plan Takes Shape"[173]

The 1934 Zon Petition

While conducting Shelterbelt planning in summer of 1934, Zon was concurrently working with Bob Marshall to put together a petition to be sent to the member of the Society of American Foresters' editorial council. In the petition, Zon and Marshall lobbied for changes to be made in the *Journal of Forestry*'s editorial politics and practices. The unprecedented document was signed by twelve foresters and came to be known as "The Zon Petition." The twelve signatories outside of Zon and Marshall included George P. Ahern, Carlos G. Bates, Earle H. Clapp, L. F. Kneipp, W. C. Lowdermilk, E. N. Munns, Gifford Pinchot, Edward C. M. Richards, F. A. Silcox, and William M. Sparhawk. Nine of the twelve men held ranking positions in the federal government. The petition was submitted to the editorial board of the *Journal of Forestry* on June 13, 1934.

The petition criticized the *Journal of Forestry* directly, arguing that critical forestry issues happening in the forestry profession were "discussed not from a social standpoint or in the spirit of the New Deal" in the journal. Though Zon's group had gained a foothold in New Deal government, they were frustrated that the *Journal*'s editorial board was not allowing the content of the journal to reflect these ongoing political changes. The petition called for a separation between the *Journal of Forestry's* Executive Secretary and the Editor-in-Chief, with space created to allow the Editor-in-Chief to be of independent opinion. At the time the petition was submitted, Franklin W. Reed was serving as serving as editor-in-chief of the *Journal of Forestry*. Former editor-in-chief Emanuel Fritz, who served from October 1930 to December 1932, later described Zon's petition as an "attempted use of the *Journal* by a clique of socialistic convictions."[174]

The Zon petition was a "watershed moment in the history of American forestry,"[175] as it signaled an open breaking point between the factions within forestry that had been more covertly warring for some time. On one side was Zon's group of foresters who viewed forestry as an ecological science and who believed it was the active duty of the forester to aid in forest preservation. On the other side were foresters who felt that forestry's duty should be a focus on improving practical methods and skills for more efficient forest management, including technical solutions for logging and cooperation with the private forest industry. Many on this side of the split had ties to the private lumber industry. It was the contention of the Zon petition that the *Journal of Forestry* had grown increasingly supportive of the lumber industry at the expense of publishing scientific research that was less technical but had more current political relevance.

In August of 1934, after the announcement of the Shelterbelt Project, Zon corresponded with Ahern, urging him to update and edit a list of specific grievances against the Society of American Foresters that had been compiled in 1932. "Much water has passed under the bridge since then," Zon wrote "not that the essential points you bring out have been much changed but there has been a new shift in the actors…possibly the same villains but in new roles and disguises."[176] He also suggested that Ahern remove specific names of stakeholders, noting that "wherever names are mentioned there is always a suspicion of the author trying to settle personal scores…if names are omitted, you could present it for publication in the *Journal of Forestry* and secure its rejection, but without giving the Editor-in-Chief legitimate reasons for rejection."[177] Zon encouraged Ahern's "virile, frank, and outspoken criticism," noting that "the real issue that has arisen in the Society is just what your paper brings out, namely, a conflict of social points of view. On the surface it may be a question of separating the Executive Secretary from the Editor-in-Chief, or insufficiency of the proper editorials, or what not, but back of it all is really a conflict of two diametrically opposite social points of view."[178]

The *Journal of Forestry*'s editor, H.H. Chapman, agreed to a publicly aired debate on the topic. They solicited requests for comment from the ranks of the Society of American Foresters, and 87 members responded with comments. In the October 1934 issue of the *Journal of Forestry,* Chapman devoted nineteen pages to publishing their thoughts. Chapman wrote to section of the member list, asking for their suggestions for a new editor. Zon wrote to Edward C.M. Richards, Chief Forester for the Tennessee Valley Authority asking for suggestions to send Chapman. "In answering it, my mind turns first of all toward Bob Marshall as the man to take the job of editor for the

Journal," he wrote, "…of course the heart of the matter is what we are working for is someone with a general liberal outlook or philosophy of life, as contrasted with that of a reactionary or ultra-conservative tendency. Unfortunately, it seems to me that the bulk of those people who are like-minded with us on this point are included with the list of signers of the petition."[179] Bob Marshall responded to Chapman with a full list of candidates, explaining that though he was "instrumental in drawing up the petition," it wasn't composed with any specific candidates in mind. At the top of Marshall's list was Bill Sparhawk, followed by Carlos Bates, who was working with Zon on the Shelterbelt Project.[180]

Huntington Supports Resettlement

Environmental determinist Ellsworth Huntington, then a Research Associate in the Department of Geography at Yale University, was among the first academics to decry the idea of the Shelterbelt program. Huntington's comments against the Shelterbelt came at an address given to the Society for the Protection of New Hampshire Forests in early September of 1934. The address generated so much interest among the Society of American Foresters that it was later run as a print article in the *Journal of Forestry*.

Huntington's address contrasted the Shelterbelt Project with the federal government's plan to retire submarginal land from agricultural use by purchasing it from farmers directly. The purchase of this 'submarginal' land channeled relief funds directly to farmers who were in desperate need of financial assistance. Huntington was in favor of this approach, arguing that the government policy of purchasing submarginal farmland allowed for farmers to walk away from a region where "frequent crop failures render the American standard of living impossible."[181] Huntington asserted that farmers working in

and to the west of the Shelterbelt zone should only live in that region if they were willing to accept a lower standard of living. Calling the area "submarginal" for growing crops, Huntington asserted that farmers in these areas went into debt during dry years and found themselves unable to pay their debts even in years with better yields. For this, Huntington blamed the inherent quality of land in these areas, arguing that the Shelterbelt zone should be converted into "cattle country," and that the cost of necessary wells, pumps, and pipes to make water available in the area would cost less than the $75,000,000 proposed for the Shelterbelt itself.

Huntington's determinist views mirrored many of the 19th century views of the Great Plains, none more central than the idea that the region was inherently unsuitable for farming. As a result, Huntington believed that the Plains should be converted into grazing land and populations should be resettled elsewhere. Huntington directly voiced his support for population resettlement plans, calling them "well adapted" to the ultimate end of preserving the American way of life. He simply did not believe the government should attempt to take any action in effort of saving crop farming in a region he felt was fundamentally unsuited for it.[182] This was consistent with Huntington's deterministic view of climate, wherein difficult climatic conditions were thought to have a direct effect on human health, energy, productivity, worthiness, and values. Huntington took major issue with the Shelterbelt Project's efforts to alter climatic conditions and make life better for farmers on the Plains, as the notion of transforming local climatic conditions went against Huntington's fundamental beliefs about the relationship between humans and the environment, and he argued that in the end, the plan would "aggravate the very evils that it is intended to correct."[183]

Huntington recounted recurring periods of drought and climatic instability that occurred throughout Kansas from 1860 onward during the struggles to settle the Plains and blamed the climate for fueling political instability in the region. As an environmental determinist, Huntington would always come back to the belief that ultimately, the physical landscape had an inescapable effect on man that went above and beyond man's ability to change the environment. He blamed that the discontent suffered by local farmers due to dry conditions on the creation of specific domestic political movements, including the Patrons of Industry movement, the Grange and the Farmers Alliance, and eventually the creation of the Populist movement around the turn of the century. As he stated, "with the normal perversity of human beings, the farmers blamed the government at Washington for troubles due to nature… Some of their great covered wagons bore big placards that stated, "I'm going back to my relations. Damn Cleveland's administration."

Despite the clear determinist basis for his critique, Huntington couched his criticisms in claims that the Shelterbelt Project was unscientific. He claimed that the project had an "apparent lack of careful statistical analysis," though he did not specify which statistics were missing. He also claimed that the project was missing "necessary facts [which] could easily be gathered" but had not been, though he failed to point to exactly which facts or statistics had been ignored. Huntington advocated for more studies to investigate the potential effects of windbreaks in an area to the east of the proposed Shelterbelt zone and advocated for a focus on advanced long-term weather forecasts.[184]

Chapter 4: Geographical Production of Climate

"For too long geographers have forgotten that climate is an idea that emerges from the heart of the discipline – or rather that geography lies at the heart of the idea of climate."[185]

Introduction

Enlightenment thinking created a bifurcation between man and nature, a separation reinforced and produced by both capitalism and science itself. Man is able to 'produce' nature by drawing a boundary around what is understood as natural and what is not, with natural conditions cast outside the realm of politics. Historically, geographers have helped produce this boundary by setting natural conditions as the basis for understanding human societies. This specific way of looking at space casts nature as static and unchanging, denying the agency of interaction that has long existed between human and their environment and leaving space as a mere backdrop upon which events unfold, rather than something that is actively produced.

In determinist geography, the production of nature happened very explicitly. Environmental conditions were not only cast as natural, but were also believed to determine the value, productivity, and worthiness of human societies. The emergence of evolutionary science and the work of scientists such as Lamarck in the late 19th century invigorated racialized spatial theories. These theories had roots in both imperialist schema of scientific classification and the newly emerging fields of biological sciences. Geographer Ellsworth Huntington was a climatic determinist who would turn out to be the very first critic with a large platform to speak out loudly against the Shelterbelt Project.

Regional geography arose in part out of a desire to move away from overly determinist views, and it pushed back against many of the most extreme forms of determinism. Regional geography posits that the earth is comprised of naturally occurring and definable regions, which share common environmental and climatic characteristics. Regional geographers argued that regions were a spatial unit of analysis that was inherently apolitical, and thus the ideal base on which to posit other forms of human geography, such as land-use policy. Geographers such as Carl Sauer and Isaiah Bowman believed that climatic instability should be combatted through moving human populations away from zones of climatic risk and pushed for geographers to map climatic data to define climatic risk zones and design a new national land-use policy around those zones.

Geographers Carl Sauer, Isaiah Bowman, and Ellsworth Huntington fundamentally disagreed with Zon and ecological foresters about the best way to combat climatic instability precisely because their spatial ontologies always predicated human geography (including political and social solutions) on top of what they saw as an unchanging set of naturally occurring environmental conditions. By focusing on land-use policy and population resettlement as a solution to climatic instability, they reinforced underlying environmental conditions as naturally occurring and relatively unchangeable. By contrast, Zon's ecological and interrelational approach to forestry understood environmental and economic conditions as irrevocably linked. Geographical critics of the Shelterbelt project all posited spatial ontologies which produced climate in such a way as to section it off from political debate, a belief that impacted their reaction to the project and ultimately changed the course of the project itself.

The Separation of Man and Nature

For many in the modern west, nature is understood as what comes before, or exists outside of, humans and society. When westerners imagine a "natural" world, we primarily imagine a world without humans in it: pristine forests, clean air and water, and balanced ecosystems. The idea of nature also harkens back to our own most "natural" state as humans: who we are at our core, our sense of innate and untamed being before society disciplined ourselves into something else. For many, this nature exists as a static backdrop into which humans were placed.

Neil Smith[186] traces the principal founding of today's common understanding of nature back to the Enlightenment, and more specifically, philosopher Immanuel Kant, who defined what he termed an *internal* and *external* nature. For Kant, external nature comprised the earth's physical environment, whereas internal nature related to the inner passions of man. Kant believed that the world, in its external reality, was always at once mediated by our perceptions of it. Thus, in Kant's view, the mind does not merely describe the world, but instead actually constitutes the world. It is in this way that the mind serves as the method for overcoming the contradictory split of internal and external nature at the level of the individual, while culture serves this purpose as at a societal level. Kant operated under the belief that the world (as an external reality) was always foremost mediated by our human perceptions and saw geographical knowledge as a way to help unify and synthesize information about the world.[187]

This conceptual separation of man from nature accomplished a task that was critical for the development of modern capitalism. By distinguishing nature as distinct from God, it became possible to externally examine the processes by which *nature* worked. God may

not be knowable, but the human mind could puzzle out the processes of nature. This specific framing of nature as existing an external object is "neither arbitrary nor accidental":

In the labor process, human beings treat natural materials as external objects of labor to be worked up as commodities. Producers put the "mechanical arts" between themselves and the objects of labor in order to increase the productiveness of the labor process, and so if science is to function as the means for developing these "mechanical arts," then it too must treat nature as an external object.[188]

The demarcation between science and nature is bound up in the processes of production, as science is employed to increase the productivity of labor and to make possible new commodities. The boundaries we draw around what is considered natural, what is scientific, and what is human are themselves partially produced by and tied to our economic systems. Alongside western science, it is industrial capitalism that has shaped today's current views on nature the most, and which has helped forge a modern-day conception of nature that is full of contradictions. In modern conception, nature is "a universal outside history and the product of history, accidental and designed, wilderness and garden."[189] The division of man and society from nature holds a huge amount of contemporary power.[190]

Deterministic Geography

Geographers have long tried to capture the differentiation and complication of the world, grappling with the very notion of spatiality to find processes that explain the workings of the world in a way that carries scientific legitimacy. Science itself predicates a bifurcation between human society and the natural world, leaving geographers to wrestle with how exactly to put human and nature back together when producing

geographic theories and spatial ontologies that posit how space works. During the 1920's, the discipline of Geography was undergoing major changes. Physical geography was shifting into the study of geomorphology, while human geography found itself lacking its own set of unique disciplinary concepts. Geographers, in search of new concepts to keep the discipline relevant, started what Livingstone has termed the "geographical experiment": studying the world while keeping nature and culture together in the same framework. Geography increasingly sought to emulate the leading science of the day, evolutionary biology. As geographers attempted to legitimize idea about society and environment with science, the field turned increasingly toward Neo-Lamarckian ideas and biological metaphor.

Lamarckism is principally comprised of two beliefs: that organisms can pass off acquired traits directly to their offspring, and that internal will, habitat, and environment can cause organic variation.[191] These ideas were incredibly appealing to geographers, because they placed "environment" at critical explanatory role for understanding both nature and culture. Taking up the mantle of climatic determinism, geographers were able to theorize that social and cultural geographic variation were a direct result of the earth's inherently different physical regions, allowing them to explore and explain the difference among places and landscapes. This entry point allowed geography to enter the realm of what was considered 'legitimate' science, but this had less to do with any inherent scientific basis or value, and everything to do with a need to be "socially and politically functional."[192]

The first president of the AAG was William Morris Davis, the "progenitor of scientific geography"[193] in the United States and founder of Harvard's geography

department.[194] At the turn of the 20th century, geography was still closely aligned to geology as a discipline, but geographers studying human agency and landscape were starting to push for their own disciplinary identity. Though principally a geomorphologist, Davis wanted to move past what he saw as old-fashioned geographic teleology, and to instead focus geographers on the more modern idea of evolution. His interest in organic analogy led to a Neo-Lamarckian basis for much of his work, following in the footsteps of Guyot. Davis credited Guyot's *The Earth and Man* with giving geographers the "first great impulse toward the cultivation of geography as a serious and independent science" through his "spirit of rational correlation."[195] Davis held a belief in the connected and divine ordering of things, from landforms to climate to human resources, and believed these orderings were connected and reinforcing. As he wrote in 1924:

"The Creator has laced the cradle of mankind in the midst of the continents of the North, so well made, by their forms, by their structure, by their climate, as we shall soon see, to stimulate and hasten individual development and that of human societies; and not at the center of the topical regions, whose balmy, but enervating and treacherous, atmosphere would perhaps have lulled him to sleep, the sleep of death in his very cradle."[196]

By the mid-1910s, Davis was starting to produce Harvard doctoral students of his own, many of whom continued to keep nature and culture together in the same analytic framework, much like Davis himself. One of these students was geographer Ellsworth Huntington, a geographer from Illinois who graduated from Wisconsin's Beloit College in 1897. Huntington's first academic post was at Euphrates College in Kharput, Turkey, where he served as an assistant to the President of the college. While in Kharput, Huntington spent his free time mapping the geology of the region and began studying small lake south of the city. It was in Kharput that Huntington theorized that long-term climate

change might be tied to events in human history, such as migratory movements.[197] His work in Turkey gained him entrance to Harvard, and he left Turkey to study under Davis in 1901.

In 1902, Davis and Huntington traveled together to Central Asia under the sponsorship of the Carnegie Institution, with Huntington on the look-out for signs of historic climate change. Huntington continued his travels beyond the initial expedition, ultimately traveling for more than two years through Asia. Work based on his extensive traveling was published as *The Pulse of Asia,* but Huntington found that Harvard University was not satisfied with it. In particular, Robert de Courcy Ward found Huntington's understanding of climate to be unsatisfactory, much to the disappointment of Davis.[198] Undeterred, Huntington began teaching at the Department of Geography at Yale University, where he received his doctorate in 1909.

From 1910 to 1915, Huntington worked for Yale in conjunction with the Carnegie Institute, often working out of their Carnegie Desert Laboratory, located on the outskirts of Tucson, Arizona. At the Desert Laboratory, Huntington began studying California tree rings to understand the history of climate and rainfall in the region. The Carnegie Desert Laboratory was a brand-new form of experiment station dedicated to ecological research: Carnegie Labs were field research stations situated in landscapes scientists knew little about and included mountain, desert, and coastal locations. Carnegie Labs became groundbreaking sites for science due to their emphasis on understanding the interrelations between living things and their role in the struggle for existence. The Carnegie Labs allowed for a focus on plant physiology that provided an opportunity for ecologists to break out of old habits and push forward into new research agendas. Dedicated research labs, set

away from the distraction and obligation of multi-use research labs in University settings, provided researchers with the focus and resources to do their work, and was coupled with a push for new research methodologies. The Desert Laboratory set a national research agenda for scientists, modeling the ability to move away from simply cataloguing and classifying species toward studying the interactions between those species and their environments in a dynamic way.[199] After Huntington's time at the Desert Laboratory, he was increasingly convinced that climate was a huge driver of human activity.

In 1915, Huntington left Yale University in search of more freedom, but found it difficult to publish and obtain academic work. As America entered World War I, Huntington found work through the intelligence community and began writing textbooks. Much of his writing turned toward civilization and race. Huntington came to the conclusion that the world's climate has not been steady over time, and believed the past was, on the whole, more "moist" than the present, a change which he hypothesized occurred in "great waves."[200] He believed that a country's distance from equator was predictive of the economic development potential level of that country, as he felt that a short growing season was "favorable to human progress" and helped lead to achievement and growth, while tropical climatic conditions in the world's "torrid zone," where things grow easily, halts the advancement of those races. He referred to inhabitants of the tropics as "slow and backward" as a result of the area's "damp, steady heat."[201] Huntington argued that though humans are intimately connected to the weather that rules their daily lives — depressed by storms, brightened by sunshine, and making weather a center of daily conversation topics — they have struggled to understand the underlying role it may have had in the development of the world's great civilizations. As President

of the Association of American Geographers in 1923, Huntington's ideas were prominent and legitimized by the discipline.

In Huntington's view, areas of the world where high civilizations have prospered are all characterized by specific climatic conditions. He therefore theorized the conclusion that such climatic conditions were necessary for the development of civilizational progress, though not a guarantee of it. Huntington described the world's non-white population (specifically those native to Africa, South America, Asia, and the East Indies) as "dull in thought and slow in action" and "one of the white man's greatest obstacles."[202] He did not believe that a good climate alone was capable of immediately improving the health of a race, or raising "a stupid and degenerate race to a high level,"[203] but saw the impact of a poor climate as nearly inescapable, even for the white race. By asserting the existence of racial differentiation and basing it in what he claimed was the 'science' of environmental conditions, Huntington was able to propagate explicitly racist theories as being apolitical.

Huntington studied the records of thousands of factory workers and military students along the eastern seaboard in an attempt to tie productivity levels to the changing climatic conditions as they progressed through all four seasons. His results indicated that peak amounts of physical activity occurred when the average daily temperature was between 60 and 65 degrees, mental activity peaks at an average outside temperature of 38 degrees, and that climatic changes at moderate intervals could be beneficial to productivity. Based on these results, Huntington created a world map that showed human energy distribution on a global scale. Though Huntington believed that the quality of one's climate was a major factor in the potential for one's productivity, he also believed

that even the best climate was not enough to mitigate what he believed were absolute and scientific differences between races. In his words, "As the plum differs from the apple not only in outward form and color, but in inward flavor, so the negro seems to differ from the white man not only in feature and complexion, but in the workings of the mind…cultivation may give us superb plums, but they will never take the place of apples."[204]

Huntington believed that economic system of slavery was of little to no value to the North because the North's climate was such that white men were able to be "tremendously energetic" on their own and were able to provide fully for themselves through hard work. Under such conditions, slavery would have provided white men with little to no economic benefit, as "the labor of such incompetent people scarcely sufficed to provide even themselves with a living and left little profit for their masters."[205] He argued that slavery was profitable in the South only because even the white man suffered under the South's climatic conditions, and the work of the white man "was not of much more value than that of a negro…it was easy to fall into the habit of using his superior brain, and letting the black man perform the physical labor."[206] Huntington blamed southern white poverty on "run-down" and "unkempt" farms, arguing that the best Southern farms were equal to those of the north, and demonstrated the full potential of the best citizens. Huntington's explicit and essentialized racism was such that he could never allow for non-white races to be equal to those of the white man except in instances of the lowering of the white man due to a deficiency of character or climate.

In the Bahamas, Huntington saw that white and black were relatively equal, which he attributed to "a marked retrogression of the white race in regions which are

climatically unsuitable."[207] When white men moved to these inferior climates, he argued that they suffered declines in both physical and mental energy, became careless with sanitation and nutrition, and thus more easily fell victim to disease and weak bodies. This compounding cycle made it difficult for white men to overcome their own circumstances, leading to "ignorance, prejudice, and idleness."[208] He also believed that white Bahamans were handicapped by the climate to such an extent that their innate capacities were raised as soon as they left for more suitable climatic zones, where their racial inheritance was "still good" and their abilities notably rose. An exception for this was with poverty-stricken white populations working in villages, often in the lumber industry, where "genuine abnormalities of both body and mind" were visible, and potentially attributed to the "intermarriage of cousins."[209]

I believe Huntington's climatic determinist were the source of his negative reaction to the Shelterbelt Project and his criticisms of it, as the project asserted a spatial ontology that was antithetical to Huntington's own. Huntington believed that environment was predetermined, unchanging, and impacted human productivity and value. By contrast, the Shelterbelt Project was built around the idea that environmental conditions were impacted by, and could be improved by, economic and political systems. Huntington believed that the productivity of farms was tied to the capability of individual farmers and the area in which they lived, seeing some areas of the world as inescapably unsuitable for agriculture. Zon believed it was the duty of forestry to work toward the material improvement of people's lives, which meant looking for solutions to change and improve agricultural conditions regardless of where people lived and worked. Even during his time, Huntington's views on civilization and race provoked attention and

debate. Isaiah Bowman, as director of the American Geographical Society in 1924, was said to have published Huntington because his work was "highly provocative" and "led to fruitful discussion."[210]

Regional Geography and Bowman's Science of Settlement

Isaiah Bowman grew up in rural Michigan, where he worked as a teacher before pursuing his dream of attending college by registering as a student at Ferris Institute in Big Rapids, Michigan.[211] At Ferris, Bowman was taught by geographer Harlan H. Barrows, through whom he was introduced to Charles MacFarlane from Michigan State Normal College. Greatly taken by MacFarlane, Bowman transferred to Michigan State Normal College in Ypsilanti by 1901, where Bowman was taught by geographer Mark Jefferson, a former student of William Morris Davis. Jefferson believed that the human-environment relationship should be studied not in terms of the physical environment's effect on human nature, but in terms of human impact on the land.

In his 1928 article *"Civilizing Rails,"* published in *Economic Geography*, Jefferson argued that human civilizations were made great because of their communication linkages. As he wrote, "What was the Beagle [Darwin's ship] doing there in the Chilean archipelago when Darwin made his famous voyage in her? Charting the channels for all the world to find their way."[212] Jefferson's arguments were not divorced from the ideology of white supremacy. He wrote about the appeal of the railway being so great that men of all races would "yield to the white man's vehicle…this is a beginning of acceptance of the white man's civilization, an acceptance of the idea of white superiority, not as a slave who accepts power that it is too painful to deny, but as a learner who recognizes that his teacher can do things that he cannot and does not yet

know how to do."[213] Jefferson recommended that Bowman spend a year studying with Davis at Harvard on the condition that Bowman eventually return to be a teacher himself at Michigan State Normal College.[214]

While Jefferson influenced Bowman in the realm of human geography, Davis influenced his take on physical geography, channeling many of Ratzel's philosophies into an American context. Bowman developed an interest in "humanized landscapes"[215] and received his doctorate in Geography in 1909 from Yale University. His early work was in the realm of physical geography, studying water supply issues in Indiana and taking part in 1907, 1911, and 1913 expeditions to South America with Yale University and the American Geographical Society serving as sponsors.

By 1927, Bowman's interests turned toward the world's pioneering belts, culminating in his *Foreign Affairs* article "The Pioneer Fringe." Bowman was interested in establishing a 'science of settlement' by studying zones where settlers' living conditions were similar to those of the early pioneers. Bowman viewed these settlers as trapped between the push and pull of natural and economic pressures: pushed into less expensive territory to escape high taxation and but at the mercy of the elements and living in places where climate was not well understood, and which may not be suitable for agriculture. Bowman did not view their low standard of living as having an economic basis, but a climatic one. Thus, Bowman's interest in climate was specific: he focused on understanding climatic stability through the creation of climatic classifications of land that were based on physical variability.[216] Bowman hoped that his science of settlement could determine once and for all which areas were suitable for new agricultural development and which were not. The determinism espoused by some of his early

geographic mentors such left an imprint on Bowman's thinking, as he continued to advocate for a link between quality of land and the quality of human character.

University of California Berkeley professor Carl Sauer epitomized what Bowman thought geographers should be. To Bowman, Sauer representing a forward-looking and supposedly apolitical geography that was neither a fully natural or social science. Though he had been one of climatic determinist Ellen Semple Churchill's students, Sauer played a large role in moving geography past environmental and climatic determinism. In his graduate field work, Sauer came to the realization that not all land uses were inherently productive and believed that man held the power to transform the land, rather than be determined by it.[217]

In 1925, Sauer had published *The Morphology of Landscape* in which he argued that culture is a force that can work both on and with nature, and that the intertwining of the two created what he termed "ways of life." Sauer argued that human cultural works ultimately impact the physical landscape, just as the physical landscape can provide setting for human societies. Sauer believed that for a geographer to understand culture, it was necessary to learn to read the physical landscape, including reconstructing the historical geographies of places. Sauer felt that to define geography as a study of mere environmental influence necessarily assumes the existence of such environmental influences. For Sauer, every physical landscape was necessarily different, with no two valleys or two cities alike, and he saw geography as the ultimate systematic study of land. Sauer's arguments that culture shapes the landscape as much as the landscape shapes culture served as a rebuttal to environmental determinists and set the foundation for what became known as the Berkeley School of human geography.

Sauer himself was directly critical of climatic determinist Harlan Barrows, calling him a man of "narrow horizons, lacking in originality, and a drillmaster who squelched any talk from the ranks."[218] Sauer was critical of efforts to have geography become more biological, and saw the geographic embrace of human ecology as a step backwards for the discipline. Climatic determinism's fall within the discipline precipitated the removal of a necessary causal link between natural and cultural phenomena within the same explanatory framework. This split human and physical geographers apart from one another, creating a divide within the discipline. Partially as a bridge for this divide, Sauer argued that geography was not about just nature or culture but was instead best understood as a science of regions. The concept of geographic regions served as a point of synthesis that brought together both nature and culture and allowed for them to be systematically analyzed. Sauer's regional spatial ontology aligned with Bowman's desire to elevate geography as an apolitical science capable of making contributions to national policy debates.

Like missing the forest for the trees, Sauer argues that the focus on discrete research objects such as soil or botany alone dampened researchers' ability to generalize across space. Sauer advocated for reintegrating specialized knowledge with *land* as a point of synthesis and the geographic region as the unit of analysis. Within a given region, Sauer argued that the physical landscape undergirded the economic dimension of a given area, with the natural dimensions of the land influencing the occupation, utilization, possession, and exploitation of land's physical qualities via a human economic system. Because regional analysis rests first on an understanding of the

region's natural physical qualities, any further analysis of a region's social qualities were argued to be inherently apolitical given their grounding in objective natural science.

Sauer built his case for the importance of regions by situating them first and foremost in the physical and surface qualities of a landscape, tied very closely to climate. Though Sauer did not see climatic regions as being yet fully defined and classified, he felt that with the gathering of climatological data there was a path forward for making this happen, citing Koeppen's work as an example of recent successes in climate classification. Once fully defined, knowing a region's climatic variability would aid social scientists and economists in understanding the potential social productivity and profitability of the land. Climatological data would make it possible to classify a region's climate properly, but in order to understand the variability of any region's climate, the data must be mapped.

Using this framework, the geographer and the tool of the map become apolitical necessities for understanding and analyzing complicated spatial processes. Sauer argued for a more central role for geography as "organized knowledge of the land,"[219] and for the creation of a new body of government officials and academic researchers to focus on land problems and serve as a conduit between the natural and social sciences, with geography and climate data at the center. Central to Sauer's goal is the centering of both geographers as a go-between for the natural and social sciences, and the spatial unit of the region as the proper unit for analysis of researchers of both. "This larger science of geography is…the obligation to put the pieces together."[220]

Geographical Production of Climate

Geographers of the early 20th century linked nature and culture together in their spatial theories. Space itself is actively generated by structural and contingent processes with their own specific materialist histories. Space is not simply a stage upon which events are allowed to play out, but rather, it is the events and processes themselves, specifically situated in the context of a contingent and unfolding history, which actively *produce* space in the form of a spatially differentiated physical built environment. The ongoing production of space is therefore influenced by the specific material conditions and the mode(s) of economic production under which it is generated, particularly given that a mode of production will create spaces that ensure its own survival. Space is an ongoing product of interconnections, something always under construction, a sphere that holds a "simultaneity of stories."[221]

The Shelterbelt itself was produced not only through Zon's scientific plans, Roosevelt's support, and the labor of thousands who planted trees, but also by Huntington and Bowman's criticisms of the project. The ways in which Huntington, Bowman, Sauer, and Thornthwaite viewed the world, understood space, and saw the role of nature and environment in the production of climatic conditions was not passive. They actively produced their own understandings of climate that went out into the world and did work: these ideas created push-back against the project, changed opinions, and appeared in newspapers. The materialist history of this criticism is itself an example of the way in which space is constantly produced.

The shift from seeing space as a passive field to an always-produced and always-becoming sphere changes can create new possibilities for thinking through power

relations. Rather than taking things for being given as they are, we can notice permanence, flows, and differences in the world and understand them as produced. Tracing the source of these productions allows us to understand the processes of power, and of resistance to power, that shape the landscapes we inhabit, live, think about and walk through every day – or that exist a world away from us. These spaces and places are in our lived realities and in our collective imaginaries. This understanding of space opens the idea of nature itself as being open, changing, and contingent.[222]

I agree with Neil Smith, who has argued that nature is 'produced' when the materialist history of a place and the political and economic forces that have help produced it are sectioned off and environmental conditions are cast as "natural." The production of nature plays out in the Shelterbelt debate through what I am terming the production of climate. The Shelterbelt Project was, at its core, a fight between ecological foresters who understood climate as produced – a continual product of human and environmental history – and those who cast climate as a natural and static set of environmental relations.

Chapter 5: The Shelterbelt Project

"The [Shelterbelt] scheme is like trying to grow hair on a bald head"

Royal S. Kellogg[223]

Introduction

As the Shelterbelt Project began, Zon tried to gain the professional support of regional geographers such as Isaiah Bowman and C.W. Thornthwaite, who instead tried to distance themselves professionally from the project. Bowman ignored Zon's request for a debate on the project in the *Geographical Review*, instead authoring an unsupportive article in the *Geographical Review* and a critical section in a Report of the Science Advisory Board. Sauer and Bowman continued to push instead for federal funding to collect long-term climatic data to help them define climatic regions, allowing for the creation of a new federal land-use policy that would define zones of climatic risk.

Criticism of the project within forestry came primarily from Zon's adversaries in the Society of American Foresters who had long pushed back against his vision of forestry as an ecological science, as the Shelterbelt because ensnared in the larger divide happening between Zon's group and the Society of American Foresters. Negative press coming out of the academy made its way into the popular press, dampening Congressional support for the project. Project Director Paul Roberts fought yearly for funding, but despite near-unanimous approval from local farmers, the project's critics secured a win against the project, successfully blocking it from full Congressional funding.

Negative Press Begins

Huntington's address set off what would become an increasing amount of negative press for the project. In the same month, an article ran in The New York Times under the headline "Tree Belt Arouses Little Enthusiasm,"[224] detailing skepticism from some Plains farmers about their expectations for the project. Farmers' main concern, according to the article, was that Shelterbelt benefits may take years to materialize, while their need for relief was immediate and urgent. The article also inverted the history of the Great Plains, calling its void of trees one of the "features" that drew settlers to the area. Despite this, the article goes on to detail some of the success that tree planting in Nebraska forests had seen in previous decades. The Associated Press quoted a local farmer as exclaiming that the Shelterbelt Project was "the craziest thing the Government has done…it just won't work."[225]

Having been called "the most ridiculed project of the New Deal," much of the negative public reaction seems to have come from the national press framing of the initial press announcement, which was at once both "overdramatic and oversimplified."[226] Many Americans, not understanding the intricacies of the proposed network of belts, initially thought that Roosevelt's plan called for a singular and solid line of trees to be planted straight down the center of the country, bifurcating the nation in two. National critics "hooted and raged: the idea was as silly as pouring plaster of Paris on listed ridges or spraying banana oil on the dust."[227] Editorial writers around the country picked up on this, and "started to pound out sarcasm by the column."[228] Despite some of the outcries in the national press, there was also excitement brewing among local farmers on the

ground. The day after the first New York Times article, the Forest Service was already "deluged" by requests for more specific project details.[229]

Around this time, Silcox began to consider the idea of bringing Zon to Washington to serve as a general forest adviser. Richards wrote to Silcox on the matter, nothing that "it is my very strong conviction that the Forest Service and the forestry movement as a whole in the country needs a lot more of Zon's thoughtful attention."[230] The prospect of moving Zon back to Washington coincided with Pinchot's possible return to the capital, and friends saw it as a chance to strengthen their political alliance. There was also a sense that with the Shelterbelt Project underway, a victory had been scored. "With GP [Gifford Pinchot] back in Washington, the group of real aggressive foresters will gather as of yore on Rhode Island Avenue [Pinchot's personal residence in Washington] and we will get somewhere. We will need Ned Richards, Bennett, Marshall, and then we can defy [C.C.] Compton and his minions [at the Society of American Foresters], Reed, etc." Ahern wrote to Zon about the possibility. Ahern expressed confidence that the Shelterbelt Project was on a path to success, noting to Zon that Zon's sons would have a "a great heritage" and "their grandchildren can point with pride to the great shelterbelt providing manifold blessings and object lessons." The Shelterbelt might also be a "source of worry to [Emanuel] Fritz, surplus timber, erosion control, etc."[231]

On September 16, 1934, The New York Times published a letter to the editor written by longtime Zon critic forester Royal S. Kellogg, under the headline "Proposed Tree Belt Regarded as Futile: Forest Planting Scheme Is Condemned as Expensive, Difficult, and of No Use When Done."[232] A member of the Society of American

Foresters with ties to the lumber industry, Kellogg criticized the project on a series of small details, including doubt over the project's acreage projection totals, skepticism over the project's time frame, and disbelief that the project would yield any timber for fence construction, saying "if trees are already growing where the belt is to be planted, it looks rather foolish to cut them for fence posts…there is practically no native timber of fence-post quality growing in the area, and no timber of any kind in most of it." Kellogg also questioned the science behind the arguments made for shelterbelts as a tool for moisture conservation, arguing that in order for shelterbelt to yield any real moisture protection, they should be planted six to a mile, rather than one per mile. Kellogg's tone throughout was dismissive, calling the project a "scheme" devised by "Brain Trusters"[233] that was praised only among those "who know nothing about the climatic and physiographic conditions involved." Kellogg describes the Plains as meant for grass and not trees: blue stem grass in the valleys, bunch grass in the countryside, and buffalo grass on the plains. Kellogg blames the rise of Midwestern agriculture for destroying the grasslands by digging up the dirt and readying it to be carried by the blowing winds, but similar to the philosophy of Clements' climax community, he seems to believe that focus should be on returning the area to native grassland. Siding with Oklahoma Governor William H. Murray, who Kellogg notes is also against the project, he declares that "the scheme is like trying to grow hair on a bald head."

McCarl Freezes Funding

In September of 1934, Comptroller General John McCarl ruled against Roosevelt's full budget allocation to the Shelterbelt Project in the first-ever instance of the Comptroller General denying a request from the President of the United States.

President Roosevelt's July 1934 executive order allocated $15,000,000 of emergency agricultural relief funds, of which $10,000,000 was set aside for use in the Shelterbelt Project's beginning phases. United States Controller General John R. McCarl objected to Roosevelt's proposed use of these funds on the grounds that federal emergency funds should not be used for what he considered a long-term project.[234] The freeze of Shelterbelt funding by McCarl required an immediate political solution. Roosevelt personally negotiated a deal with McCarl that authorized funding for initial project expenditures but prohibited any land purchases.

Fund dispersal occurred in September of 1934, but McCarl was only willing to allocate the Shelterbelt Project $1,000,000 out of the $15,000,000 that Roosevelt allocated for drought relief.[235] This $1,000,000 had limits imposed on it: it could be used only for initial preparations for the project, including the purchase of seeds, nursery development, and setting up initial project staff. McCarl argued that any amount of money spent that exceeded the initial million dollars would violate the intention of the drought relief act. The exclusive use of these funds was for, in McCarl's words, "investigations into the practicality of establishing tree growth in the semiarid region of the Plains states" and "to contribute to the fullest extent possible to the aid of drought stricken farmers."[236] This meant that the project's budget could only go toward material purchases and employee salaries, even though in the initial conception of the project, the expectation was that land purchases and leases would comprise the bulk of the funds.

News of the budget reconfiguration arrived just one month after field headquarters were opened at Lincoln, Nebraska. Paul Roberts was announced as the Shelterbelt's Project Director just one month later, in October of 1934. Despite

immediate funding challenges, Roberts and Silcox charged ahead. McCarl's objections were only the beginning of financial worries for Shelterbelt Project staff: Congress was not sold on the project, and the recurring negative articles about the Shelterbelt in the popular and academic press compounded this issue. Government officials working on the Shelterbelt Project would face a year-to-year uphill battle to continually fight for the project's funding if they could not gain Congressional support. Recognizing this how critical funding would be, Project Director Paul Roberts set out to mobilize broad support for the project across all six states from the ground up.

Planting Begins

Roberts' goal was to begin tree planting in all six states in the spring of 1935. This would be no small task, given the short time frame the project employees would have to select planting locations and create workable arrangements with individual landowners. Understanding this, Silcox directed Roberts to mobilize a groundswell of support among local farmers. Roberts' strategy was to begin plantings across all six states at the same time, with plantings distributed as evenly possible, so as to reach as many farms as possible. Roberts believed that when farmers saw a demonstrated difference made in or around their community, they would voice their support for the project to their representatives, and the project would have a better chance of getting Congressional approval. Silcox hoped that regular Congressional funding of the project would lend it "scientific and political respectability" and potentially even serve to expand the mission and of the Forest Service itself.[237] In Roberts' words, the Shelterbelt Project became "a veritable crusade" among the personnel for the project, "likened by older

members of the Forest Service to the crusading spirit of that organization in the time of its beginnings."[238]

Zon Seeks Bowman's Backing

On October 16th of 1934, Zon wrote to Isaiah Bowman, then serving as Director of the American Geographical Society, seeking support for the Shelterbelt Project through the American Geographical Society's publication the *Geographical Review*. Zon opened his letter to Bowman with reference to their "mutual friend" Ellsworth Huntington's "categorical and ex cathedra pronouncement" on the Shelterbelt, wryly noting that Huntington "somehow knows that the project is foolhardy because, he knows, that trees won't grow there."[239] Expecting Bowman to take his side in the matter, Zon reminded Bowman of his own "sane conclusions" about the Plains region that were published in Bowman's *Forest Physiography* which, Zon notes, were "based on a large number of studies." Zon quotes *Forest Physiography* as saying that "a large part of the plains county will support a limited forest cover and the Prairie-Plains can be made to grow trees almost everywhere."

Acknowledging that the Shelterbelt Project would require "careful consideration" of climatic and physical factors, Zon suggests to Bowman that geographers could "perform a real service" to him and the project by inviting a "thorough" discussion in the *Geographic Review* by "competent geographers" – though Huntington should still "of course be invited to contribute his views and these should be answered by someone who has given time and study to the problems of dry land vegetation." While polite, Zon's distaste for Huntington is not veiled in the letter. Zon addresses Bowman as an

intellectual equal and seems to expect that Bowman will be on his side of the debate as a man of science.

And indeed, Bowman had been critical of Huntington in the past. In letters to Australian geographer Griffith Taylor just six years earlier, Bowman said that Huntington had "an almost fine disdain for facts…I regard a larger part of Huntington's writing as a waste of time to read."[240] However, if Zon expected Bowman take his side, he was to be disappointed. On October 30, 1934, Bowman issued his reply to Zon. The letter was friendly, noting that if Zon was ever on the east coast, Bowman "should like to talk to [him] about the Shelterbelt" in person. Bowman wrote that he "appreciated" Zon's kind words on his publication of *Forest Physiography*. However, Bowman asserted that Zon "misread" his work. Referencing Silcox's article for The New York Times from July 1934, which included a map of the proposed Shelterbelt, Bowman declares that Zon's proposed Shelterbelt would be planted on an area that Bowman had defined as the "High Plains," the "Great Plains, and "only the last portion of it on the north falls within the 'Prairie Plains'…well to the east in Kansas and your shelterbelt lies far to the west."[241] Bowman adds that he is "not in any sense trying to frame a critical argument in so brief a space as a letter" but completely ignores Zon's request for a debate in the *Geographical Review*. He concludes that he should be "glad to see" any critical material on the Shelterbelt. There are no further indications of correspondence between Bowman and Zon on this issue in the American Geographical Society archives.

Just days before composing his reply to Zon (October 27), Bowman had received a letter from Professor Frank E. Williams of the University of Pennsylvania, who was then serving as the Secretary of the Association of American Geographers. Williams

wrote to Zon about his desire for the Association of American Geographers to come out officially against the Shelterbelt Project. Writing that he knew the Association "does not pass resolutions in regard to any debated problem," Williams asked Zon if there might be anything that "we, as a group, could possibly do to let it be known that we are decidedly opposed to the sheltered-belt [sic] proposal."[242] Bowman's reply to Williams is dated October 30, the same day he replied to Zon. In it, Bowman tells Williams that it would be "unwise" to pass a resolution against the Shelterbelt, as resolutions can be "ineffective" and Williams could not be sure that a resolution would "receive unanimous approval."[243] Bowman notes the danger of a resolution going the other way, as they would not to accidentally lend support to a "debatable" plan. Despite tampering down Williams' request, Bowman advised him not to "infer…that I am in favor of the shelter belt. I am taking a swipe at it in the January Review," he concludes.

In October of 1934, Zon wrote to Thornthwaite, asking for his help with the Shelterbelt Project. The Shelterbelt Project needed to submit findings to Congress by January of 1935, and Zon was eager to gain Congressional approval and funding. To speed the process along, Zon offered Thornthwaite clerical assistance from the Forest Service in exchange for his own work in service of the Shelterbelt. Thornthwaite was concerned about involving himself with the project, and he wrote to geographer Carl Sauer about the problem. "[My colleagues] urge me to do it. It will get material which I need in the climatic risk study, which our limited staff and resources will not make it possible for me to get otherwise," he said, but adding this his "worry" was his "reputation if I am found in company with this disreputable organization."[244]

Zon and Thornthwaite worked out a compromise solution that allowed Thornthwaite to work on the project: Thornthwaite's contributions would be fully attributed to him and the Study of Population Redistribution but included as "objective analysis" subcontracted by Zon, rather than a full author whose name was being lent in agreement with the project. This allowed Thornthwaite to get help from the Forest Service, Zon to utilize Thornthwaite's climatic data, and Thornthwaite to politically shield himself from any potential fall-out from involvement with the project. Though he agreed to Thornthwaite's terms, Zon himself was disappointed in Thornthwaite's reaction, as he wrote much later to him:

"If you place your reputation above the search for truth, you do not exhibit a true scientific spirit, but mere desire to play safe, so characteristic of our professorial colleagues. I thought that liberal economic thinking went hand in hand with bold unconventional thinking in the realm of science. Am I doomed to another disillusionment?"[245]

Thornthwaite's reaction to the Shelterbelt Project echoed the issue Sauer found with Lowdermilk of the Soil Conservation Service: ecological foresters such as Zon and Lowdermilk focused on the relationality of interactions, while Sauer and Thornthwaite's regional approach essentialized the conditions of any given area. As a result, Thornthwaite and Sauer found themselves with adverse reactions to projects which sought to alter or engineer natural conditions of an area. Sauer, Thornthwaite, and Bowman all believed that proper classification of a climatic zone would allow society to choose the best and most productive land-use, rather than considering that potential land-use could change based on altering the underlying natural conditions.

Chapter 6: Geographic Regionalism and New Deal Science

"On the farms, in the large metropolitan areas, in the smaller cities and in the villages, millions of our citizens cherish the hope that their old standards of living and of thought have not gone forever. Those millions cannot and shall not hope in vain. I pledge you, I pledge myself, to a new deal for the American people."

– Franklin D. Roosevelt's Address Accepting the Presidential Nomination at the Democratic National Convention in Chicago, 1932

Introduction

President Roosevelt's New Deal policies created a new relationship between academic scientists and the federal government. Before the Great Depression, academic researchers primarily relied on financial support from 'apolitical' private foundations or patrons such as the Carnegie Institute. After the Great Depression, changes in the institutional framework of science gave science an important role in the creation of federal policy, created funding of scientific research by the federal government, and set the stage for new debates about the relationship between science and politics. Leaders in the scientific community found opportunities to pair scientific research with federal goals and private industry, embracing science as a mechanism through which they could restore stability to the country. With such a vital role for science to play in national life, New Deal policy makers argued that research agendas should not be left solely to the whims of private institutions but must also be coordinated and embraced at the federal level to ensure that scientific research was used for the good of the nation.[246]

The pairing of federal policy with academic science elevated geographer Isaiah Bowman to the role of Chairman of the National Research Council. Bowman believed that the solution for stabilizing agricultural areas was to be found in the development of a new national land-use policy based improved climatic science. For Bowman, climate

science came in the form of 'climatic zones' constructed by geographers, whose work he had long-sought to situate within national policy debates. Bowman greatly admired the work of geographer Carl Sauer, whose work pushed back against deterministic geography by arguing for what was termed 'regional' geography. Regional geography proposed that the world could be divided into discrete 'regions,' a concept which built off Frederic Clements' work on climax communities. Citing Clements' work as a scientific basis, Sauer deemed regions to be an apolitical unit for social, cultural, and political analysis. Sauer believed that if scientific regions were properly measured and defined, man could look at the characteristics of any given region and determine which land use would be productive within that region to best serve his social needs.

Bowman had long-standing interests in what he termed the 'science of settlement,' and he believed that Sauer's scientific regional analysis would make it possible to comprehensively determine the nation's areas of most extreme climatic risk and redistribute the nation's population accordingly. Bowman elevated Sauer's work within the National Research Council precisely because he saw within it a politically persuasive justification for promoting land-use policy as the scientific solution for agricultural risk while also centering geography and geographers at the center of national land-use policy. By publishing Sauer's work through the Science Advisory Board, Bowman argued that geographers were uniquely positioned to utilize 'apolitical' regional climate science to solve the stability crisis the nation was facing.

National Planning and the National Research Council

The post-Depression search for stability resulted in not just by an alliance between government and industry, but an alliance between government, industry and science. New

Deal policies aimed to harness technical knowledge generated by objective and apolitical academic science by pairing it with the power of private industry and regulating it through government control. The desire to bridge academic science, industry, and government together were not entirely new. The United States government created the National Academy of Science in 1863 at the beginning of the Civil War to leverage the country's best scientific knowledge to aid the Union Army. During World War One, the National Academy of Sciences formed the National Research Council, which was again an effort to strengthen national defense capabilities through the pairing of government, science, and industry.[247] Outside of these military uses, however, domestic scientific funding had been steadily defined through its relationship to university research centers and private foundations such as the Carnegie Institute. Scientists did not receive or seek federal funding for their projects. Thus, even after the Depression hit, many scientists distrusted the idea of pairing science with government and worried about the politics of centralizing scientific funding or research agenda through a government agency.[248]

In June of 1932, the National Research Council voted to establish a new position of Chairman, thought to be equivalent in stature to that of a university president. As envisioned, having one individual at the helm would allow the National Research Council to act swiftly and decisively as necessary to support American science interests in the short-term. This would be vital to ensuring that the National Research Council was responsive during a critical time for science and the national political agenda. At age 52, geographer Isaiah Bowman was among the more youthful members of the National Research Council. His positive ties to Franklin Roosevelt, developed during his work on The Inquiry (an advisory body that functioned during the Versailles peace negotiation at the close of World

War One) made him a prime candidate for the job. Members believed that Bowman had the potential to help make real inroads for the National Research Council with the incoming Roosevelt administration. [249] Bowman himself, then President of John Hopkins University, lobbied Roosevelt for the appointment partly due to their joint interest in "the settlement question,"[250] an area that Roosevelt had always maintained an interest in as well. By 1933, Bowman had accepted and assumed the new chairmanship role.

Bowman had a long history of working to elevate the discipline of geography and attempting to integrate academic geography with American governmental policy. More than a decade prior to assuming the chairmanship role, Bowman served as the director of the American Geographical Society (AGS), which he immediately set out to reform. Bowman changed the name of the AGS' publication from *The Bulletin* to the *Geographical Review*, aiming for the publication of scholarly articles with popular appeal, and moved from a monthly to quarterly publication rate. Bowman also moved to put more emphasis on regional geography studies and began networking with heads of major institutions to find areas "where geography could be muscled in."[251] By 1918, Bowman had arranged for a partnership between the AGS, the War Department, and the National Research Council that weaved geography into the military curriculum at land grant colleges around the country. Before his appointment to the chairman role of the National Research Council, Bowman was serving as President of the John Hopkins University.

The Science Advisory Board

One of Bowman's first tasks after assuming the chairmanship position of the National Research Council was to leverage the National Industrial Recovery Act (NIRA) and the National Recovery Administration (NRA) to better position science for use in

national recovery and planning efforts. Bowman entered into conversations with Commerce Secretary Daniel Roper about the potential for scientific research to aid the NIRA and formulated a detailed plan for ways in which the National Research Council could potentially be of service.[252] The Industrial Recovery Board already maintained three planning boards: the Industrial Advisory Board, the Labor Advisory Board, and the Consumer Advisory Board. To reinforce his agenda, Bowman wanted to add a fourth: the Science Advisory Board. The Science Advisory Board would create new opportunities for academics to directly influence federal policies Bowman cared about, and he found his opening through shared research interests with Secretary of Agriculture Henry Wallace. In early 1933, Secretary Wallace approached the National Research Council for advice on how he could best modernize the Weather Bureau. Bowman seized upon the opportunity. Bowman's interest in the Weather Bureau was tied to his belief that improved climatic data was needed to help geographers map climatic risk zones, something he saw as key to social stability. Bowman convinced Wallace that a new Scientific Advisory Board would be capable of providing Wallace with data and advice for the Weather Bureau and any other governmental problems requiring scientific advising.[253]

The Science Advisory Board was established through Executive Order on July 31, 1933 under the joint jurisdiction of both the National Academy of Sciences and the National Research Council. Roosevelt's executive order was patterned to a draft created by Bowman himself and many of the men Bowman had hand-picked for the Board were granted appointments, with Karl Compton appointed as chairman. The creation of the new Science Advisory Board, however, was never formally approved by the National

Academy of Sciences, whose president felt the new Science Advisory Board was redundant with the power inherently invested in the National Academy of Sciences. Thus, an immediate rivalry was born between the Science Advisory Board and the National Academy of Sciences, despite the Science Advisory Board technically falling under partial control of the National Academy of Sciences.[254]

Karl Compton, the newly appointed chairman of the Science Advisory Board, had come to believe in the necessity a philosophy of cooperation between government and industry, arguing before the Boston City Club in early 1933 for a "planned economy" in the United States comprised of "distributed labor, production regulated to demand, risks minimized, wealth distributed in accord with justice and [the] best interests of society."[255] One of his first acts as chairman of the Science Advisory Board was to propose including scientific research as one of the activities supported financially by Roosevelt's National Industrial Recovery Act (NIRA). Compton's proposal, titled "Recovery Program for Science Progress," called for $16,000,000 of federal funding over six years to support National Research Council-selected research projects. Under the proposal, Americans with technical training could benefit from short-term employment on the funded research projects, which Compton believed would lead to the creation of entirely new scientific industries in the long term. Compton began working on the report with Gerard Swope, the President of General Electric and a member of the National Recovery Association. After submitting the revised plan to Secretary of the Interior Harold Ickes, Compton was handed a set-back. Though Ickes was sympathetic, he did not believe that the NIRA could legally fund scientific research under the definition of "public works" as defined in the act.[256]

For his next attempt, Compton scaled up even larger, creating a proposal for the creation of a National Research Administration. Compton's National Research Administration would fund fellowships, grants, and contracts for the creation and dissemination of scientific knowledge nation-wide, with an even larger budget than the Recovery Program for Science Progress. Compton requested a budget of $100,000,000 over five years. Key to Compton's proposal was explicit language arguing that science must remain free from partisan politics, with all funding for the proposed National Research Administration to be managed through twelve directors appointed upon recommendation of the National Academy of Sciences. The reaction to Compton's new proposal was swift, with steep criticism coming from Compton's colleagues on the National Research Council and Science Advisory Board. Most of the pushback Compton's proposal received was against the idea of government-funded science. Many did not believe it could ever be sustainable in the long term and many worried that government control of research funding would ultimately constrain the independence of universities.[257] Compton's plan was ultimately brought before Roosevelt under the name "Science Funds," where $75,000,000 was proposed to be administered through a scientific advisory board. Ultimately, the proposal failed to advance, in part due to opposition from Frederic Delano of the National Resource Planning Board. Compton's proposal made clear the deep divides that existed over the role of government administration and funding of science during a period when science was mobilized to aid in national recovery and stability efforts.

Bowman's Land Use Planning Committee

Bowman's activities as part of the Science Advisory Board included the creation of the Committee on Land Use Planning. Bowman had long seen pioneer belts as a

"remedy" for the moral degradation of urban living,[258] and the Science Advisory Board created an opportunity for him to elevate his interest in the 'science of settlement' to the national stage. Bowman's personal interest in pioneer belts motivated him to find ways to systematically identify sub marginal land to demarcate which land could in fact still be salvaged for use by a pioneering class. Thus, determining which land was capable of being restored to full use was a high priority for Bowman. Bowman established the Science Advisory Committee's Land Use Planning Committee to lobby for geography's place in this process.[259] The board was initially composed of Bowman, J.C. Merriam, and C.K. Leith, but in April of 1934, Sauer was officially added to the group. Bowman also considered adding forester Henry S. Graves.[260] Sauer joined the Land Use Planning Committee after submitting a preliminary report on land-use that the group hoped to publish.

Sauer's Land Use Report

Sauer had begun work on the report in February of 1934, working out of the American Geographical Society offices and taking trips to Washington, DC to consult with government scientists.[261] As Sauer described to student Charles W. Thornthwaite, writing the report was "a queer job and taking form slowly…Bowman got the idea (and he is one of the hard driving members of the Board, as well as head of the National Research Council) to get into the land question."[262] Sauer's report was published as "The Preliminary Report to the Land-Use Committee [of the Science Advisory Board] on Land Resource and Land-Use in Relation to Public Policy" in late 1934.

Sauer's report argued that as universities and government research bureaus turned increasingly toward the production of specialized scientific knowledge, the "awareness that the content of an area was coherent"[263] was lost

One of Sauer's continual calls throughout the report is for the funding of more extensive and reliable climatic data and map making. He calls for the completion of country-wide topographic mapping, air surveying of urban areas, the creation of maps showing current relief, drainage, and transportation data for the country, and a renewed focus on the art of map making. Noting that most American-made maps are merely utilitarian, he asks: "who would linger and 'invite his soul' over the products of American map making? This preoccupation with the baldly utilitarian map may be the reason why we are regarded as the least map-conscious of civilized peoples" and why the country lacked so many necessary maps.[264] Sauer saw climate foundational to understanding the physical and social possibilities of a region. "In whatever way we think of the land or whatever land it is that is the subject of our inquiry," he wrote, "that land is conditioned by the sky under which it lies and by the climate which is proper to it."[265]

Sauer's call for climate data, critically, differed from most of the ongoing collection of climatic data that was ongoing during the period. Most climate related data collected by the federal government was organized through the Weather Bureau. The Weather Bureau focused on short-term weather forecasting but produced climatological data only incidentally. Sauer referred to climate data as the "step-children"[266] of the Weather Bureau, arguing that the federal government needed to increase funds to produce more records, establish additional cooperative stations and evaporation stations, and conduct more snow surveys. Sauer's understandings of climate, and thus of the geographic region more

generally, had their roots in Clements' conception of a climax community. Indeed, Sauer believed that climate could be understood as "a fixed area within which certain average relations obtain between temperature and moisture, expressed in a seasonal regime." Sauer's climates were cohesive and identifiable, much like Clements' climax communities, which had an inherent and ideal vegetative state they naturally returned to. Sauer's even borrowed terms from biology, referencing "the plant formations of Clements…whose stability was based on their balance with the climate of an area."[267] Sauer's climatic regions were most clearly defined at their geographic center, but toward the edges, they began to align with neighboring climates. "In this sense, then, a climatic region is true to type only in its interior parts… when a disastrous drought overtakes a Missouri Valley States, it may mean that for that year the weather conditions characteristic of the steppe or even of the desert have pushed eastward far beyond their normal area," Sauer wrote.

Critical to the idea of a cohesive regional climate was the implication that zones of climatic risk could be determined by sufficiently mapping and analyzing climate data across geographic regions. Sauer argued that a climate itself "may be properly thought of as an area" with margins that "are annually and irregularly shrinking or expanding." Thus, when two climates exist alongside one another, one of which is safe for growing crops and the other is not, "the zone of oscillation represents the area in which the farmer is forever shaking dice with the weather. This is the zone of climatic risk."[268] All told, Sauer developed four primary possible land classifications: areas of economic development, areas of marked economic stability, marginal areas, and areas of chronic crisis. Unlike climax communities which were always working toward achieving their ideal climatic

state, Sauer worried that the social equivalent was more dangerous. "When its climax is reached, stagnation or, very likely, deterioration sets in" for man.[269]

Sauer's conception of climate that is presented in his land use report accomplished three critical tasks. The first was setting the geographic region as a cohesive unit of analysis with land as a point of synthesis for both natural and social sciences. The second was arguing that geographic regions were inherently apolitical due to their grounding in natural features rather than social or political divisions. The third was establishing a cohesive conception of climate that was tied to naturally occurring geographic regions, with mapped climatic data forming a necessary basis for the possibility of comprehensive land-use planning. Sauer approached land-use by first considering a region's natural dimensions, then factored in its economic possibilities, resulting in a mapped geographic totality.

Thornthwaite's Climatic and Physiographic Section

In 1933, the Department of the Interior created the Soil Erosion Service, directed by H.H. Bennett with W. C. Lowdermilk serving as vice director. Lowdermilk began his career as a timber acquisitions officer for the Forest Service. After time spent researching forestry at the American Union University in Nanking, China and the completion of a Ph.D. from the University Of California School Of Forestry, Lowdermilk re-joined government service in 1930. This time, Lowdermilk supervised a soil erosion experiment station in California. By 1933, he was Assistant Chief of the Soil Erosion Service.[270] Sauer's 1934 Land Use Report culminated in the suggestion that a Climatic and Physiographic Section be created within the Soil Erosion Service, with Sauer himself recommending former graduate student C.W. Thornthwaite to head it up as director. By

late 1934 Sauer was personally lobbying Lowdermilk to hire Thornthwaite, writing that Thornthwaite "could do a valiant job of educating the [Soil Erosion Service] as to the possibility of marshalling evidence in maps. Lowdermilk seems well inclined towards the idea and a little pushing might put it over."[271] When the Soil Erosion Service was moved to the Department of Agriculture and renamed as the Soil Conservation Service in 1935, Lowdermilk became the Assistant Chief. Lowdermilk took Sauer's suggestion and continued with plans to hire Thornthwaite, who was officially deemed the head of the Soil Conservation Service's Climatic and Physiographic Research Section in July of 1935.[272]

One of Sauer's graduate students at the University of California Berkeley, Thornthwaite's first major scientific contribution had come in 1931 with the publication of "The Climates of North America: According to a New Classification," published in the *Geographical Review*. During Thornthwaite's time under Sauer at Berkeley, Thornthwaite carefully studied the work of famous German climatologist Köppen, but it was not until a subsequent move to teach at the University of Oklahoma that Thornthwaite theorized that Köppen's climate classifications failed to fully account for Oklahoma's climate.[273]

Köppen was trained as a plant physiologist, completing a dissertation on heat and plant growth in 1871 and using his background in early evolutionary biology to suggest that plants may serve to integrate climatic elements.[274] Köppen's early work focused on developing formulas for mapping the world's climatic zones based primarily on global vegetation maps. Köppen's classifications were always posited as works in progress, with Köppen himself keenly aware that he had not yet determined an effective method for

incorporating moisture effectiveness in his classification. Thornthwaite's 1931 article argued that it was the effectiveness of both temperature and precipitation *together* that helped define climatic zones, where the effective temperature was determined by plant growth as a result of temperature, and effective precipitation was based on both the amount of precipitation as a measure and also the measure of water lost to evaporation.[275] Thornthwaite used Weather Bureau data to create a Precipitation Effectiveness Index for almost two dozen weather stations in the United States, establishing five grades of humidity (wet, humid, sub humid, semiarid, arid) and five grades of vegetation classification (rainforest, forest, grassland, steppe, desert). He also developed a Temperature Effectiveness Index, identifying six temperature zones (tropical, mesothermal, microthermal, taiga, tundra, frost). Thornthwaite used these indexes to reclassify North American weather stations and drew a new climatic map for the continent. During the same period, Thornthwaite's former graduate school colleagues John Leighley and R.J. Russell, both also students of Sauer's, were hard at work on their own classification systems.

Thornthwaite's residence in Oklahoma brought his attention to the climatic troubles of the Great Plains and he believed that it was limited moisture availability that was key to solving the settlement problems there.[276] In 1934, Thornthwaite left his position at the University of Oklahoma to work for the Social Science Research Council's Study of Population Redistribution. Financed in part by the Rockefeller Foundation, the study was intended to determine which parts of the United States population should be relocated for better economic opportunity. His work culminated in the 1934 publication of "Internal Migration in the United States." Taking climatic

conditions as a given, Thornthwaite concluded that Great Plains inhabitants were faced with either permanent poverty or permanent subsidy.

By September 1935, Thornthwaite's Research Section was approved to establish a climatic research center in western Oklahoma. Thornthwaite worked cooperatively with the Weather Bureau to establish two hundred separate weather stations within an area of about 1,800 square miles, allowing for the collection of dense climatic data from a little-understood climatic region.[277] By January of 1935, Sauer ended his working relationship with the Soil Erosion Service after eight months conducting soil erosion research in the southwestern United States based on a research agenda he had proposed through the Land Use Planning Committee.[278] Sauer expressed frustration on working with Lowdermilk, explaining in a letter to Bowman that Lowdermilk

"*…wants pure science, not a critique of such of their activities as disregard scientific foundations… They are New Dealers and are bringing the millennium quickly. I belong to the Old Testament, think that the lot of man on earth is hard, that he must atone bitterly for his transgressions and walk in the fear of the Lord. I should base my soil erosion control work on the prophecies of Jeremiah and bring the judgements of the Lord to the individual farmer. They are still included to offer forgiveness of sins by engineering magic instead of insisting upon a change of heart. In the South salvation comes by terracing, and every time they build a terrace they make it harder for the tough-minded agronomists and foresters to get their work in. They should face the longer-range prospects of the operations, but I have seen no general willingness on their part to do so, though Bennett will do it momentarily and quite candidly. It will be interesting to see whether this whole thing turns out to have been a comedy of errors in the end.*[279]"

Sauer ultimately believed that land use analysis should be put to work to determine which areas should be farmed and which should not. He did not believe in engineering solutions to provide stability. Bowman himself eventually soured on Lowdermilk, writing in 1947 that "it was high time that someone took Lowdermilk down a peg…Lowdermilk has posed long enough as a disinterested scientist and an expert on

Palestine. He has merely used the language of science in an impressive way to convince the Zionists that they are right."[280] Bowman's antisemitism may have been reflective of others' attitudes at the time as well – Raphael Zon and Bob Marshall's position as outsiders within the forestry community was not based solely on their scientific views, but also because both Marshall and Zon were Jewish, setting them apart from the overwhelmingly white Anglo-Saxon composition of the Society of American Foresters in the 1930s.[281] Meanwhile, Thornthwaite's work in the Climatic and Physiographic Section gave him access to climatic data that would come to interest Zon.

Chapter 7: Prairie States Forestry Project Part II

Journal of Forestry Takes on the Shelterbelt

In the October 1934 issue of the *Journal of Forestry*, Chapman issued an editorial called titled "Professional Idealism," which framed Zon's petition against the *Journal*'s leadership that would appear later in the pages of the issue. Zon wrote to Marshall regarding the issue, calling "Reed's symposium" and Chapman's editorial "very entertaining." "Oh, Lord!" Zon wrote, "Be merciful to our Society!"[282] To Richards, Zon wrote: "I hope the October issue of the *Journal* did not provoke you to profanity. It made me only sad. Apparently our group and the other group speak entirely different languages."[283] In his reply to Zon, Richards explained that he'd recently had conversations with "some of the more or less disgruntled past leaders in the profession" who "do not like the drive with which the twelve willful members of the Society started their petition."[284] Marshall wrote to Zon, citing the *Journal*'s October issue as evidence that the group needed to create their own publication, noting that they were given one page to respond to the sixteen pages devoted to negative commentary in the *Journal*. In the meantime, Marshall suggested that the group continue to pitch articles to the *Journal* about the *Journal*'s censorship.[285]

As further insult to Zon, the *Journal of Forestry* published the text of Ellsworth Huntington's Shelterbelt denunciation in the November 1934 issue, reported by The New York Times on November 10, 1934 under the headline "Tree Belt Project Hit by Huntington: Yale Geographer Says Plan Would Aggravate Evils It Seeks to Correct." Huntington was quoted as calling the project "unscientific." Nationwide press for

Huntington's deterministic views counter-acted initial positive press the *Times* had given the Shelterbelt when it ran Silcox's announcement of the project.

Accompanying Huntington's article in the November 1934 issue of the *Journal of* Forestry was an editorial written by Herman H. Chapman, who, like Huntington, was also a professor at Yale. Chapman declared that the recent Shelterbelt announcement "caused a widespread feeling of uneasiness and apprehension, and even active protest" throughout the ranks of Society of American Foresters members. Chapman argued that forestry as a profession had struggled to achieve the same reputation of scientific legitimacy as other science and engineering professions had achieved, and blamed "unscientific statements regarding the effect of forests upon climate and rainfall" for this undeserved reputation. "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…comes this sudden front-page publicity, reviving all the old misguided motions of forests and climate," he lamented. He declared that all "thinking foresters" would necessarily "regret" what the public would come to interpret from such claims as "man can ameliorate the effects of weather on a large scale, just as he can around his home."[286]

Chapman additionally cited former President of the Society of American Foresters Walter Mulford as expressing his "*grave misgivings*" about the project. Mulford believed that any positive results from the project would be so small, the project money could be put to better use elsewhere, and that in the meantime, the project ran the risk of becoming "a boomerang which will give forestry a terrific setback in public opinion."[287] To close his editorial, Chapman theorized that the technical challenge of the Shelterbelt would necessarily create administrative challenges, adding that "if to this is added the

announced and enforced policy of the administration to require political endorsement for all non-technical supervisory positions, the wisdom of devoting this huge sum…may well be questioned," closing with the recommendation that any money spent on the Shelterbelt Project would be better spent to achieve that direct recommendations outlined in the Copeland Report, which he felt was representative of the "best technical thought" in regard to the future of American forestry.

In the following month's edition of the *Journal of Forestry,* the debate continued, as Chapman published a digest of letters and opinions on the project, as well as articles submitted by Royal S. Kellogg, William Hall, and Carlos Bates. Chapman, in his "Digest of Opinions Received," explained that he had sent out 44 surveys to those 31 "who by their position as scientists or foresters and experience within the proposed Shelterbelt zone were capable of both sound and independent judgment on the questions involved," and that out of the 31 surveys returned to him, not a single survey taker gave "unqualified approval" to the Shelterbelt Project.[288]

However, F.E. Cobb, the State Forester of North Dakota wrote in support of the Shelterbelt Project, noting that he has worked in tree planting on the Great Plains since 1915, has visited "practically all the townships" in the project area, and had seen shelterbelt planting demonstrations in person. He concluded that the technical aspect of the Shelterbelt project was "entirely sound," and that with good project supervision and appropriate tree specifies selection, he expected a "high degree of success." Cobb's only hesitation was the potential effect on climate "over a wide area," as he felt that trees had not in any way prevented the current drought conditions, even in the wooded sections of the Mississippi Valley in North Dakota. That said, Cobb felt that there was potential for

variation in local climatic effects: he relayed that in the North Dakota State Nursery, there was "no doubt" that northwest and southeast winds had less of an effect on ground surface evaporation with every mile of tree belt. He predicted that within the 100-mile Shelterbelt planting area, planting conditions would likely be improved, but would not expect any cumulative effect outside of the change in local conditions.[289]

Another supporter was Raymond J. Pool, Professor of Botany at University of Nebraska Lincoln, shared that his initial reaction to the Shelterbelt Project was "unfavorable" due to the "unfortunate and misleading propaganda that appeared in daily papers." What changed Pool's opinion of the project was the information he has since seen directly from the Forest Service, which has assured him that the project was being approached in a "scientific" manner, something he had not felt was happening based on the articles he had read.[290]

Henry Schmitz, Chief of the Division of Forestry at the University of Minnesota in St. Paul, Minnesota wrote that he was "not qualified to express any belief, in the scientific sense of the word, on the merits" but "opinion, however, is permissible where belief is not." In Schmitz's opinion, he felt generally that trees could be grown with some success in the Shelterbelt region, as long as they were provided with adequate cultivation and care. That said, he was disturb[ed]" by the level of publicity the project had received, which he found to be "superficial and unscholarly." He also noted that a lot of the publicity he had seen for the project "implies that these breaks will exert a general influence on the climate of the region as a whole," something for which he would like to see more scientific evidence for. Schmitz advocated for careful scrutiny to be applied to

the project - not because he was inherently unsupportive of it, but because President Roosevelt "would not wish to make any serious mistake."[291]

Paul B. Sears, a Professor of Botany at the University of Oklahoma also seemed disapproving of the amount of popular press that the project had received, but expressed some willingness to reconsider the project, saying that he has since "understood that some of the publicity...does not accurately represent what is really intended." However, he expressed further concerns that the project plans "seem to have been developed without much consultation of ecologically trained men who are on the ground," and suggested that the best way to restore ecological stability to the region might be to work on returning much of the area's native grasses.[292]

Francis Ramaley, who headed up the Biology Department at University of Colorado Boulder wrote in to express his opinion that tree planting in the Plains states could likely find some success in the low-lying areas, but that there were many other areas where tree planting would be a struggle. He felt that overall, wind erosion techniques might be more effective if tree planting was abandoned altogether, and if hardy shrubs were planted, rather than trees. "The supposed effect of tree planting on climate, is, of course, a joke" he wrote.[293] Clayton W. Watkins of the College of Agriculture, in Lincoln, Nebraska wrote that much of what the program was attempting to do was work that had been going on, in some form, in Nebraska for some time. Detailing the extensive history of tree planting in Nebraska, he revealed that the state "has been transformed, almost in one generation" from prairie to an agriculturally productive state, where it was not uncommon to see small groves and belts of trees that now existed on what had once been an entirely treeless prairie.[294]

Professor Fay G. Clark of the School of Forestry at the University of Montana wrote that he had traveled through North Dakota, South Dakota, and northeastern Montana, and the recent droughts had killed off "practically all of the shelterbelts" within the region due to a lack of water. He further explained that his feeling was that the Shelterbelt Project was "doomed to failure before it is started," and expressed concerns that the endorsement of the project by the profession of forestry would ultimately "shake the public confidence" in forestry itself when the project failed. "To me it looks like merely a political pork barrel scheme, out of which no good can come," he said.[295]

Working foresters located directly in, or to the west, of the planting area, seemed to issue the most direct support for the project. R.S. Towle of the Bureau of Plant Industry in Sheridan, Wyoming, wrote that he had been working to establish small shelterbelts in the west since 1917, and that based on his experience, there was "little difficulty" getting shelterbelts established. His main challenge over the years had been getting conifers to grow with success, but he noted even that could be done with proper cultivation.[296] Another letter in support of the project was written by C.P. Blackwell, the Dean and Director of the Oklahoma Agricultural and Mechanical College in Stillwater, Oklahoma. Blackwell wrote that he had experience studying forestry and soils in his section of the state and had in fact successfully conducted tree plantings in recent years. Blackwell felt that the Shelterbelt Project had "some merit," particularly if the project paid attention to local planting conditions and did not invest in areas where the soil and slope would not be able to appropriately support tree growth.[297]

Kellogg's Shelterbelt Scheme

In Kellogg's article, provocatively titled "The Shelterbelt Scheme," he asserted that the Shelterbelt project's only benefit would be potential relief through direct employment, but otherwise proclaimed it had nothing to offer from a "practical or scientific standpoint." He noted his general support for shelterbelt planting in its traditional form, saying that shelterbelts have "rightly" been employed on farms for "countless years." Where Kellogg took exception to the Shelterbelt program was the idea that the planting of shelterbelts would have a cumulative effect large enough to control "elemental forces." Kellogg derisively noted that supporters of the Shelterbelt project were those who "think that any kind of tree planting anywhere is a good thing" and those who "are under the erroneous impression that forestry is chiefly tree planting." He argued that in order for the project to work, there must be solid evidence that shelterbelts can in fact slow down the wind and conserve moisture, saying that otherwise the project is "a delusion and a criminal waste of the taxpayer's money which should not be countenanced by men of scientific training and accomplishments such as professional foresters are supposed to be."[298]

After reviewing a selection of studies on windbreaks, Kellogg conducted his own math to project that for the project to fully achieve its aims, 30 billion trees would be required at a total estimated cost of $450,000,000. Repeating claims he first made in his letter to the editor as printed in The New York Times, Kellogg said the Great Plains were never intended to support tree growth, only grasses, ending by saying, "we might conceivably cover the High Plains with trees and we might carpet the state of Maine with buffalo grass – but if we are sensible we shall try to do neither."[299]

An unknown poet authored the following poem to describe the debate between Zon and Kellogg:

Kellogg lives in New York City
Far away from drought and wind.
Broadway dandies never fancy
Any need for shelter belts.

When he hears about the project
He sits down and writes the TIMES
In a letter: "I know better.
They don't need a shelter belt."

"Planted trees will die on prairie,
Eighteen inches not enough.
Suffocation, radiation
Kill the trees in shelter belt"

"Zon to move to New York City
Live with me on old Broadway
Here it's cozy, here it's rozy
And forget his shelter belt."

What will happen in the future,
Zon and Kellogg only know.
Will they conquer or debunker?
I predict a shelter belt!
Thousands of miles of living fences,
Pinus, Ulmus, Fraxinus,
Ponderosa, Resinosa,
Soon will grow in shelter belt.[300]

Another forester whose response to the Shelterbelt received print space in the *Journal of Forestry* was William L. Hall. Hall was close to Royal S. Kellogg, having invited Kellogg to join the United States Division of Forestry as a student assistant back in 1901.[301] Hall grew up as a boy in western Kansas and eastern Colorado during the 1880s, and worked on experimental tree plantations under the United States Department of Agriculture in Kansas during the 1890s. His Forest Service work also included forest

surveys of the Ouachita Mountains and a recommendation that their forests should remain in the public domain. Halls' reports on the region led to the creation[302] of the Arkansas National Forest in 1907, later renamed the Ouachita National Forest, before Hall himself left the Service in 1919. By 1927, Hall was working as a private forest consultant out of Hot Springs, Arkansas. Among Hall's later work in Arkansas was a consulting job for the Dierks family of Arkansas, of whom he told their acreage was large enough to "practice sustained yield forestry and *cut trees forever*."[303]

In "The Grand Shelterbelt Project," Hall states that he often wanted to support "the bold spirits who spring gigantic, lovely schemes and endeavor to put them into effect," as such bold projects can occasionally yield success. However, he was "unwilling" to give "joyous approval or even tacit assent" to projects that were not set up to achieve success and would only be "costly in the extreme," putting the Shelterbelt Project in this latter category.[304] Hall viewed the Shelterbelt as setting itself up for a direct fight against nature itself. Referring to nature as an "antagonist," Hall argued that nature is "always on the job, always ready and able to make man's efforts look silly."

Hall argued that only a small area within the designated planting zone would support tree growth, estimated at not more than two percent of the proposed Shelterbelt zone. The rest of the planting area, he claimed, was an area where "nature with great fixity of purpose has determined upon grasses as permanent cover."[305] Hall warned that any successful belts would require great effort to be maintained, as he did not think the trees would renew through natural seedlings. "At some period in the future," Hall warned, "this administration or some later administration will recognize the failure and drop the project like the proverbial hot potato. The net result may be several hundred

thousand acres more of good western grass land broken up and exposed to the fury of wind erosion."[306]

Bates Responds

In a letter published in December of 1934, Carlos Bates "protest[ed] most vehemently" against Chapman's editorial the previous month, given that it was published "without time or opportunity" for the forestry profession to have a full discussion of the project. He argued that though Chapman claimed to be "expressing in cold blood a cross-section of the professional opinion," Bates had his doubts as to who Chapman's opinion represented and how many foresters Chapman talked to had first-hand experience with the conditions and specificities of the project itself. "If one wanted a valuable professional opinion on the feasibility of treating cancer, he would not consult lung specialists, nor would he consult general practitioners. I do not consider the opinion of the greater number of eastern foresters on this subject as of very much value."[307]

Carlos Bates began his article by acknowledging the "skepticism" of the project generated through the "popular and professional imagination" based on "honest doubts."[308] To speak directly to those doubts, Bates set out to answer the foundation of the skepticism most commonly directed at the project: whether tree growth could be supported on the Plains. Acknowledging that past planters faced severe difficulties in the region, Bates argued that through the "technical skill of the profession" and a "love for the soil" the project would succeed. Furthermore, Bates clarified that the Shelterbelt zone itself had been carefully determined, and areas with significantly alkaline soil excluded. The most ideal planting locations were described as areas with cultivated soils and only a moderate elevation change.

Bates was also attentive to the line of precipitation, running even north to south, and tapering off significantly from east to west. Bates set the extreme amount of precipitation within the zone at approximately 17 inches per year, noting that trees have successfully been grown even further west beyond that line in areas of only 15 inches of rain per year (in Montana and Colorado). Speaking directly to the issues raised by Huntington, Bates notes that it is impossible to predict what the climate might look like in the area a hundred years hence, or where exactly the next drought might strike, but that "such long-distance factors" are not normally "taken into consideration in any human activity."[309]

Bates suggests that the key to successful tree planting is less about avoiding fundamentally unsuitable areas, or unstoppable droughts, but rather that successful tree growth is found where there is "good planning and intelligent care."[310] While acknowledging that some early tree death was likely inevitable, Bates argued that even during the ongoing drought new tree plantations found success alongside effort and care. Speaking realistically about the potential for tree growth, Bates notes that shelterbelts themselves are less about the success of every individual tree, and more about what trees can provide when they are grouped together – it matters less that every tree thrives than it does that some amount can be achieved by the belt overall. "There never was a better illustration of the social axiom 'united we stand, divided we fall,'"[311] Bates wrote.

In order to address the skepticism surrounding the claims of slowing the winds, Bates pointed to the importance of the shape of the belt itself, noting that older belts are "unprotected" from the wind on their sides, rising from the Plains like a "sore thumb." The Shelterbelt trees will instead be planted "in the shape of a roof with a wide sweep at

the eaves" with the tallest growing trees planted in the center and rows of shorter hardwoods and conifers extending out at a lower level on the sides, followed by small shrubbery. The shape of the belt itself should "deflect the currents upward" in such a manner that the maximum possible protection is extended out toward the crops on the other side of the belt. He also notes that the potential effect on evaporation was likely to be even more beneficial than the direct reduction of wind velocity itself. As for the project stock, Bates describes a plan to purchase from private nurseries and grow seedlings in government nurseries, all of which should be obtained from areas west of the Shelterbelt zone so that the trees were not accustomed to great amounts of precipitation (what he calls "large, soft" trees). The trees will then be watered only lightly, planted in the ground when they are still quite young, will be planted "speedily," and should ideally be "thoroughly hardened."

In response to Huntington's assertion that the project relies on "an apparent lack of careful statistical analysis…which could be easily gathered,"[312] Bates countered that the Shelterbelt Project itself would allow for the creation of extensive field laboratories that could study the effect of windbreaks on crop value. Bates also made a case for the value of trees for their aesthetic value, saying "nowhere is their need felt more keenly than on the Plains," citing "the depressing lack of relief in the topography, the unbroken monotony of the ground underfoot, the horizon and the sky itself."[313] Bates argued that the demoralizing effect of a flat landscape and the steady beating presence of the wind, led him to believe in what he terms "largely intangible *human* values" – as he stated, "this is not the kind of a subject in which argument can have much effect; one either 'feels' these values or one does not."

Bates noted that the need was greatest on the west side of the Shelterbelt zone, and thus, the project would be carried out "*as far west as it is feasible to go*," in order to best address the needs of those who needed it most. He also stated that "the distribution of shelterbelts within the wide zone must be as even as possible" for two reasons: first, to achieve maximum benefits across the planting area, and second, that being a public project, it is "essential" that "no individual or small group should benefit to the disadvantage of others."[314]

1935 Convention of Society of American Foresters

Zon himself saw Chapman's Shelterbelt editorial response as part of the ongoing divide in forestry against ecological foresters. In a letter to Bob Marshall addressing the continued fall-out from his 1934 petition, Zon notes that he'd had a "most interesting experience" with Chapman "in connection with his rotten shelterbelt editorial."[315] "Chapman is now posing as a champion of the Forest Service in the fight against the transfer of the National Forests," Zon wrote. "Under the circumstances, we cannot very well attack a 'champ' when he is fighting presumably for the Forest Service." Agreeing with Marshall that it may be necessary to "circularize the Society ourselves," Zon concluded that "if anything is to be done, it will probably fall to our lot. This is discouraging but we may just as well face the situation realistically."[316]

In January 1935, the Society of American Foresters held its annual meeting in Washington, DC. Chapman sent a letter to the Members of the Council of the Society of American Foresters in advance of the meeting. In his letter, Chapman recounted that he had requested that each of the twelve signers of the Zon petition submit to him twelve names they felt would be suitable potential editors for the *Journal of Forestry*.

According to Chapman, only Marshall, Kneipp, and Bates responded. Chapman noted that "members present in canvassing the field and without any suggestion from me had agreed that Ward Shephard had the necessary qualifications for editor and authorized me to find out whether it were possible to secure his service on any terms."[317] Chapman corresponded with Shephard to make him an offer, but the offer was declined. Chapman then approached Butler and Graves of the American Forestry Association in an attempt to secure one of their employees, but Butler and Graves rejected the suggestion. Aldo Leopold was offered the job next on Chapman's own initiative, but he also declined. Chapman then asked the council to vote on the suggestion of abolishing solicited signed editorials by members who were not the Editor or a member of the council.

Meanwhile, Sparhawk had prepared a statement to read out loud to convention attendees that summarized the charges against the Society contained in the 1934 Zon petition. Knowing this, Chapman made a point to leave the Convention meeting right before Sparhawk's talk to travel to the White House and present President Roosevelt with the Schlich Medal for Forestry. Ironically, it was Zon, the "mouthpiece of the Pinchot group,"[318] who had drafted Roosevelt's acceptance speech for the medal, with most Zon's words making it into the final version of Roosevelt's acceptance text. The acceptance speech reflected Zon's views on forestry, reinforced by his words which Roosevelt espoused: that Roosevelt appreciated most of all "the recognition comes from a profession which from its very inception looked upon the forests as an instrument for the social and economic betterment of people."[319]

Other members of the Society came prepared for battle. Emanuel Fritz, previous Editor of the *Journal of Forestry* and Society of American Foresters council member had

prepared note cards for potential remarks against each of the twelve petition signers, who he already nicknamed the "Twelve Apostles." Chapman urged Emanuel Fritz to behave while he was gone. According to Fritz' own remembrances of the event, Fritz did not follow Chapman's instructions. "I said that one of the Apostles (a signer of the petition) had that very morning been reported in the newspapers as having been accused of being a Communist the day before in Congress,"[320] Fritz recalled. The man Fritz publicly referred to as a communist was Robert Marshall. Kneipp reported to Chapman upon his return to the meeting that Fritz had accused Marshall of being a communist. "It was my intention to point out to the Society members that this group has designs on the *Journal*, to make it a sort of propaganda organ to promote public ownership and/or federal control of all private forest land," Fritz later argued. "They even had designs on the National Parks."[321] The summary of the official proceedings of the Society of American Foresters did not publish a summary of that morning's session, though every other session of the conference was represented by a comment or report of some kind.[322] Fritz later recalled that the 1935 convention was a "turning point in the battle for federal regulation," specifically after Article X of the National Recovery Act was passed. "The Zon petition had its aftermath," Fritz said. "It left a lot of wounds."[323]

Bowman's Expanding and Contracting Desert

In January of 1935, Bowman's promised "swipe" at the Shelterbelt was published in the *Geographical Review*. In the article, Bowman took issue with the idea that submarginal lands in the west had been "permanently destroyed," pushing back against determinism by pointing instead to the climatic swings the region experienced over time. Bowman set out to examine the existing breadth of climatic ideas, "some of them rooted

in experience and scientific truth, others fundamentally unsound." Implying that the Shelterbelt project belongs to the latter category, Bowman likened the Shelterbelt Project to a determinist idea, attributing its popularity to the "layman conclud[ing] that we have only to increase the extent of tree-covered land in the plains country and we shall have improved the climate."[324] Assigning climatic outlook to irrational human emotion, Bowman claims that up until at least 1915, drought was accepted by humans as a "prophecy of doom" in bad years, while in good years, settlers declared that "a few shade trees or the breaking of new land performed miracles of permanent reclamation." Bowman then pointed to the myth of the Great American Desert, once thought vanished, but perhaps now returned, as proof that climate goes through cyclical phases. Bowman's principle opinion is the suggestion that more climatic data needed to be gathered because there would be a sound basis on which to determine scientific fact and suggests that more resources should be directed toward the collection of scientific data. As he wrote, "science means inquiry: facts plus logic. If we approach the problem in this spirit, it is hard to be positive about the great question of the degree of future aridity in the West. The main conclusion is that we ought to continue gathering records."

Bowman expressed a geographical perspective that tied economic and social destiny with physical qualities of the landscape, arguing that "physical conditions and economic and social conditions dovetail...all economic opportunities rest in the last analysis on the land and its wealth in the form of agricultural soil fertility, minerals, grass and forest growth, and water supply." He further stated that an area's physical geography and climate were of primary importance because they "show where economic effort of a given type

should be concentrated," and argued that areas with poor soil and low regular rainfall rates should be abandoned for human settlement.

Speaking in front of the American Association for the Advancement of Sciences in June of 1935, Bowman stated that the main problem should not be considered "where to place a proposed 'shelterbelt' but where to turn farm land back to range land."[325] He again suggested that we needed to establish more meteorological stations that could provide climatic data that could aid scientific decision-making. He also equated the physical qualities of the land with the character of settlers who resides there, stating:

"In any event, and whatever the balance between hope on the one hand and soil and weather possibilities on the other, we ask, wisely, I think, what kind of people and what kind of society will the high-risk areas of the western Great Plains support? Do we want that kind? Our people are our greatest resource. "Tell me what society you want," says Zimmerman, "and I will tell you what your resources are." We are dealing with a social, that is, a cultural complex as well as with a complex of natural conditions and forces."

Zon Appeals to *Science*

As future Shelterbelt Program Director Paul Roberts came to see it, the divided opinion on the Shelterbelt Project was itself geographical: the most intense project scrutiny came from academic foresters from the Northeast United States, whose interest and stake in the project was mostly theoretical. Meanwhile, foresters attached to state universities, agricultural colleges, and extension services in and around the Midwest seemed more likely to support the project. In Roberts' view, this was because many of the Midwestern foresters were already directly involved in local agriculture and ranching themselves and were much more likely to understand the "proven" benefits that would come along with a Shelterbelt project.[326] The "turmoil" among foresters over the project only served to motivate Zon and Roberts more. As Roberts later recalled, the criticism

"stimulate[d] the already high determination of those connected with it to demonstrate that trees could be planted successfully under the most adverse climatic conditions that had ever occurred in the Plains region up to that time."[327] Fueled by his own belief in the project, and in response to so many claims questioning the Shelterbelt Project's scientific foundations, Zon wrote a response that was published in *Science* just a few months later, in April of 1935.

In the article, Zon claims that President Roosevelt's vision for the Shelterbelt "caught the popular imagination as no other forest enterprise has in recent years," but that the popular vision of the project as an "uninterrupted and undeviating" series of tree plantings, running north and south down the country regardless of the soil, elevation, or direction of wind simply was not true. Once the project was "stripped of the exaggerations of its friends and the misinterpretations of its opponents," Zon explained, the plan itself was straightforward. Forest plantings would take place in a zone approximately 100 miles wide and 1,200 miles long, wherein conditions of soil and climate made tree growth possible. The center of the Shelterbelt would follow the 99th meridian, while the western project boundary would follow average yearly rainfall lines, such that the north received 15 inches and the south received around 22 inches (with the south receiving more necessary rainfall to compensate for the higher rate of evaporation).

Zon acknowledged that west of the Shelterbelt zone, tree planting was often "hazardous" for multiple reasons: low rainfall and difficult soil conditions often led to short life spans for trees with poor survival rates. He encouraged these areas to be used for cattle grazing, as many academics had proposed for the Shelterbelt zone, but for a different reason: Zon noted that existing plantings had already proven that tree planting

was possible in some of these areas, but that ultimately, there was not many crops in the area for the trees to protect. Therefore, native grasses could more easily achieve the same objectives in soil stabilization that the Shelterbelt would attempt to accomplish to the east. He argued, however, that the already existing agricultural economy present in the Shelterbelt zone was not only capable of supporting tree planting, but that it was these agricultural settlements that had the most to gain from tree planting specifically, as trees could help to "stabilize this agriculture and leave it less at the mercy of the elements."[328]

Zon went even further, breaking down the approximate area of plantable soil types running through the Midwest – out of 114,700 approximate square miles of land in the Shelterbelt zone, 66,400 square miles were comprised of hard agricultural land with fine soils. Over half of this, 36,700 square miles, was comprised of uplands, where Shelterbelt planting would be difficult. The same was true of the 4,800 square miles worth of clay-pan and alkali soils that were unfit for any tree growth at all. But 24,900 square miles of the fine textured soils, largely in the eastern section of the zone, were amenable to tree planting. Another 30,700 square miles of the total 114,700 was comprised of sandy loams, which would be favorable to planting. Out of the areas of rough land, 5,000 square miles were still favorable to planting, but another 8,000 was not. And finally, there were 4,600 square miles of Sandhills, which could handle tree planting when done in solid blocks of trees. All in all, Zon determined that 57% of the land in the Shelterbelt zone was favorable to planting, with another 39% "difficult" for planting, and a final 4% that was absolutely unsuitable.[329] While Zon agreed that these soil conditions ensured that the Shelterbelt would be challenged to plant in unending, continuous strips of trees, it did not in any way prohibit smaller strips of trees to be planted within the zone where conditions were

favorable – which had always been the Forest Service plan. Zon's attention to detail and scientific basis ran the criticism from foresters such as Kellogg, who had claimed that the Project was not collecting or using all available scientific data.

1935 Funding Troubles Continue

After the success of the first planting season, Roberts sought $10,000,000 for the fiscal year 1936 (which would start on July 1, 1935). This funding would not be easy to secure. By 1935, the national unemployment rate still hovered around 22%[330] and the federal government was heavily focused on getting citizens back to work. As part of the Emergency Relief Appropriations Act of 1935, Roosevelt proposed the creation of the Works Progress Administration (WPA), which was to be his largest work relief effort yet. Crafted as a more permanent version of the short-lived Civil Works Administration, the WPA's goal was to put 3.5 million Americans back to work as quickly as possible. Roosevelt also wanted to end direct relief efforts and close down FERA, shifting responsibility for relief efforts to the CWA.

After negotiations with Senate Republicans, the Emergency Relief Appropriations Act was passed in April of 1935, and Roosevelt chose Henry Hopkins to lead the WPA. FERA was dismantled and most of its employees were shifted over to make up the agency structure of the WPA. The WPA was designed to be a relatively lean agency with very low administrative costs and a focus on funding "shovel-ready" projects – manual labor projects that did not require intense skill that which could be implemented quickly. Roosevelt also pushed for WPA projects to improve living conditions for those struggling around the country. The Shelterbelt Project fit into this model very well. Other common WPA projects included road building and park renovations.[331]

Through the WPA, the Shelterbelt Project secured $1,990,958 for its next year, it was still less than 20% of the amount Roberts originally sought. Complicating things further, WPA funding came with strings attached. In order to ensure funding was being used in support of work relief efforts, WPA funding came with a requirement that money it gave to projects must be spent directly on labor costs. This requirement was intended to ensure that federal money went directly to putting Americans back to work by taking workers of direct relief rolls and assigning them to work relief programs. As an additional requirement, the WPA required that the Shelterbelt Project hire at least 90% of its workers from relief rolls in an effort to move people off of direct relief and into work relief. The 10% allowance for non-dole workers was intended for instances where skilled workers who may not have been on relief rolls were required to help complete a project. Employment was limited to one person per household, with privilege given to the household head. Between 1935 and 1943, the WPA ultimately employed jobs for 6.5 million Americans. WPA workers were involved in a wide range of projects, from conservation and dam building to tree planting, building fire towers, sealing mine shafts, responding to natural disasters, and building streets, schools, libraries, parks, firehouses, and sewage systems. For the Shelterbelt Project, it ultimately meant that there was almost no general-purpose funding for the project at all, making it a struggle to secure even basic equipment. WPA funds were also distributed directly at the state level, rather than aggregated to the project level for internal dispersal. This added an additional layer of complication for the Shelterbelt Project, which had shifting costs spread out over six states.[332]

During the first year of its operation, the Shelterbelt Project was purchasing fencing material, paying farmers a rental fee for use of their land and labor costs for help building fences, and paying for seedling purchases and seedling cultivation. To conserve costs where possible, Shelterbelt officials worked directly with the Agricultural Adjustment Administration (AAA) to make sure that the project's tree plantings fit within the guidelines of the AAA. The AAA aimed to help stabilize crop prices by encouraging farmers to stop production of crops that were experiencing a surplus. This meant that a farmer who leased his land to the Shelterbelt Project satisfied the requirements of the AAA, which worked to the interests of the farmer, allowed for payment of the farmer through the AAA, and reduced overall costs for the Shelterbelt Project.[333]

Unfortunately for the Shelterbelt Project, in January of 1936, the AAA was declared unconstitutional by the United States Supreme Court. Given their budgetary constraints, the Shelterbelt Project only had one option: they would have to convince farmers to work with them cooperatively, with no direct financial incentive. Farmers would have to produce a planting site, prepare and cultivate the land before planting at his own cost, and also provide his own materials for fencing. Those were the new, necessary conditions to receive a shelterbelt, though WPA funds could still be used to plant the trees and build fences using the material that had been previously provided by the farmer.

In practical terms, however, project employees were immediately constrained by the availability of seedlings in stock in regional nurseries. Looking forward to future years of the project required a complex nursery operation to get underway immediately. Project employees scoured private nurseries to determine the level of inventories for

hardwood planting, and looked to Forest Service nurseries in Halsey, Nebraska and Monument, Colorado to determine conifer stock. The project would need an estimated 70,000,000 plantable seedlings for each future year, a number that far outstripped what the region was accustomed to supplying. For the year 1935, the project could obtain only 1,430,675 seedlings from commercial nurseries, with another 4,200,000 seedlings taken from Forest Service nurseries.[334] On March 19, 1935, the very first tree of the Shelterbelt Project was planted near Magnum, Oklahoma – an Austrian pine seedling on the farm of H.E. Curtis.

Bowman's Science Advisory Report

During the same period, Bowman authored *The Land of Your Possession*, an appendix to the Report of the Science Advisory Board published in September of 1935. Speaking about the article at a meeting of the American Association for the Advancement of Science, Bowman argued that under-staffing of research personnel in the Weather Bureau was responsible for an insufficient amount of climatological data. Bowman's continued emphasis on the need to collect long-term weather data was based in his belief that climatic scientists should be focused on defining climatic regions rather than attempting to mitigate climatic conditions on the ground. These stable definitions of climatic regions could be used to help define a land-use policy that told populations where farming should and should not be carried out. Bowman argued that this long-term data collection strategy was necessary to help combat the worst effects of drought. "The immediate problem of the West is not where to place a proposed 'shelter-belt,' but where to turn farm land back to range land," he argued, once again attempting to steer the policy conversation toward land use and risk classification.[335] Bowman was interested in using

climatological data to help establish a wide-scale land restoration and retirement policy. He also noted that the work of the Science Advisory Board around land-use had been conducted specifically to address the question of climatology and "continuing wise-use" land policies. In Bowman's analysis of the prairie, deficiencies of the prairie were compensated for by industrial farming machinery, with tractors lowering production costs while also reducing labor requirements. Aware of the machinery's impact, Bowman argued:

"While in simple teleological phrase it may be said that God made the drought for ends of his own, it was man who raised the dust because he did not have the proper ends in view. … It is said that Kansas is the only state in the Union that contains more trees now than it did before it was settled. But even here, man's benevolence and wisdom are limited to the eastern two-thirds of the state. In the western third, right in the area of greatest climatic and agricultural risk, the protective sod has been ripped off and the soil pulverized by the repeated cultivation essential to dry-farming… in some places the ground has been literally blown off down to the plow sole...hope plays but little part in bringing back a state of balance that man right now continues to disturb with criminal thoughtlessness. Hope will not bring the sod cover back."[336]

The determinist leanings of Bowman's education do not seem to have left him entirely. Describing the Plains as an area of "high risk," Bowman asks, "what kind of people and what kind of society will the high-risk areas of the western Great Plains support? Do we want that kind?"

In order to solve this problem, Bowman turned to land-use policy, proposing that the rationality of scientific forecast could help solve the problem of land use in the marginal areas of the Great Plains, allowing for decisions to be made about what should be done where, and presumably, who should live where. Bowman did not believe presume that scientific forecasting would alter climatic conditions but might provide against the effects of the weather. "A strong force of experts should be working on the mass of climatological data on the Great Plains accumulated during the past fifty years by

the Weather Bureau," he wrote. "The result would certainly be more valuable over a ten-year period than all the gold produced in the Klondike...it is such a rush that ought logically to be joined with the rush to plant trees."[337]

Bowman's primary interest was in the land that lay to the west of the Shelterbelt. Bowman argued that it was this western area that was in the most urgent need for climatological data which could help produce a land-use plan that would spell out the region's climatological risks and allow the region to have "its people redistributed accordingly."[338] Bowman favorited the collection of rainfall and snowfall data, wind duration, slope exposure, capacity of the soil to hold moisture, and to understand the success of planting experiments. He felt that the region's existing rainfall records had not been properly analyzed, questioning the methodology for how changing rainfall patterns across years were grouped between sub regions.

The climatological data Bowman was interested in acquiring was advocated for through the Science Advisory Board as part of a larger project to study land use on the Great Plains in order to understand where economic effort and resources could be concentrated and put to most effective use. Bowman felt that if land-use was not determined correctly, it would lead to moral degradation on the part of the populations living in poorly zoned areas. Thus, his ultimate use for extensive climatic data would be to classify climatic zones through which areas of risk could be determined and pioneer settlements redistributed. "The human erosion is as important as the soil erosion which it follows,"[339] he wrote.

Apolitical and objective science was of the utmost importance to Bowman, who believed that policy-making in the early 20th century was "mixed up with fact-

gathering." Bowman argued that "facts" should be gathered first, and policies built around these facts to support logical conclusions, as opposed to collecting facts to support existing policies. "A politician is most dangerous when, as medicine man, he juggles facts...not all distributional facts can be readily understood by 'a glance at the map.'"[340] The Washington Post called the report an "indirect slap at the once heralded shelter-belt of trees."[341] Authored by Bowman, the report's appendix argued that the Shelterbelt was set to fail, stating that tree plantings on the eastern edge of the Shelterbelt zone were more likely to survive than those on the west.

Funding Troubles Continue

By January of 1936, Roberts was again looking for funding, this time through Congress. Roberts' goal was to establish a funding line for the project that was not directly tied to emergency relief efforts that could help the project plan its future. Roberts wanted $2,500,000 per year, with some of that funding directed towards the Lake States Experiment Station, where Carlos Bates and his team was still conducting research related to the project. Unfortunately for Roberts, the Budget Bureau chose not to increase his appropriation, and he was once again given $1,000,000, which was to be included as a "Forest Influences" line-item in the budget of the Forest Service.[342] Meanwhile, The House of Representatives Subcommittee of the Committee on Appropriations conducted a review of the Shelterbelt Project, led by Representative Clarence Cannon, who was joined by fellow committee members Malcolm Tarver and Lloyd Thurston. Cannon in particular was concerned by the potential costs of the project in the long term, and cited Zon's early estimate that the project could require up to 3 billion trees to conclude that the total project cost was likely in the neighborhood of $426,000,000, a number 170%

higher than what Roberts had requested per year.[343] Tarver was particularly troubled by the idea that public money was being spent to conduct plantings on privately held land. The Committee recommended that the Shelterbelt Project and Forest Service at large look into redesigning the program to fit more into the bounds of the Clarke-McNary Act. On February 24, 1936, on the House floor, Representative Louis Ludlow of Indiana confirmed that the agricultural appropriation bill under consideration by the House explicitly denied funding for the Shelterbelt Project under the direction of the House Agricultural Subcommittee, led by Clarence Cannon. Ludlow stated that this denial of funds would put an end to "one of the most ridiculous and ill-conceived projects ever thought of by well-meaning and impractical officials, who actually thought they could construct a luxuriant forest belt across a part of the country where the Almighty will hardly permit a cactus to grow."[344] Ludlow went on to refer the project as an "iridescent dream," which "would not have affected climate or temperature" and was "fairly dripping with extravagance."[345]

A week later, Christopher Granger, the Assistant Chief of the Forest Service, came before the Committee again, this time with Paul Roberts and Raphael Zon. Zon introduced their re-worked plan, which would eliminate the emergency relief work aspect of the project and instead return to focus on the original intention of the work, which was systematic forest plantings on the Plains. Tarver remarked that Zon's new plan was "the old shelterbelt plan in a new dress,"[346] and requested specific language that guaranteed the farmer would pay the costs for the seedlings plants on his or her property. The next month, the Committee recommended that the "Forest Influences" budget line be eliminated from the Forest Service budget altogether. Thurston told colleagues that the

Shelterbelt Project was "one of the most ridiculous and silly proposals that was ever submitted to the American people." Jed Johnson of Oklahoma authored an amendment the House Appropriation Bill with the following language: "No part of the Appropriation contained in this act [H.R. 11418] shall be used to continue the establishment of the so-called shelterbelt project of trees or shrubs in the Plains regions undertaken heretofore, pursuant to appropriations made for emergency purposes." Rumor has it that Johnson was upset that his home county in Oklahoma was not within the original boundaries of the Shelterbelt Project, and sought to harm the program as a result.[347] Representative Phil Ferguson of Oklahoma tried to add his own amendment to the bill, asking for $180,000 to allow for the 95,000,000 seedlings growing in nurseries for the Shelterbelt Project to continue receiving care so they could still be distributed freely to farmers living in the designated planting areas. Ferguson's amendment was struck down 81 to 35.

In order for the Shelterbelt Project to survive, it would need help from the United States Senate. Silcox appeared before the Senate Subcommittee of the Committee on Appropriations in an attempt to have funds restored to the project. The Senate Committee debated whether or not the Shelterbelt Project's full $1,000,000 budget item should be reinstated, or whether the project should merely receive $180,000 to save the existing seedlings. To the Shelterbelt Project's advantage was the composition of the Senate Committee: Charles McNary had long supported the Forest Service, and both North and South Dakota had Senate representation on the Committee. Ultimately, the Senate Committee decided to restore the full $1,000,000 Forest Service budget, but not without conditions. Going forward, all plantings would need to be established in cooperation between the government and the farmer, with the Shelterbelt Project never

paying more than half the cost. With the House and Senate in disagreement, the item was moved to a joint conference committee, with Roosevelt in support of the Senate amendments. However, Cannon, Tarver, and Thurston of the House would not be denied. They were dead-set against the use of federal money for the project. The only compromise they would issue was to allow for $170,000 to "liquidate" the existing seedlings and distribute them at no cost to farmers living in the Shelterbelt zone. Without any further funding available, the Shelterbelt Project was to be discontinued.

The Secretary of Agriculture notified President Roosevelt that Shelterbelt Project funding was to be halted, and Roosevelt suggested that Shelterbelt-related legislation should be widened in scope, potentially including a national farm-forestry program that could lend the Shelterbelt Project funding stream more national relevance.[348] Hope was briefly resuscitated for the project in May of 1936 with the introduction of two bills in the House and Senate that were intended to revive the project's funding. Texas Representative Marvin Jones introduced HR 12939 to the House, while Nebraska Senator George Norris introduced Senate Bill 4723 bill in the Senate. The two "companion bills" attempted to "authorize cooperation in the development of farm forestry in the states and territories."[349] Norris was able to pass his bill in the Senate, but Jones failed to pass his bill in the House. Once again, the House of Representatives was blocking potential funding from the project. A further result of the failed bill was the realization that the nursery industry was gravely concerned about the prospect of the government establishing and funding federal nurseries that could potentially damage their business. The nursery industry was prepared to try to leverage their political representatives in Congress to work against the Shelterbelt Project.[350]

Through the fall of 1936, legislative meetings were held about farm-forestry on Capitol Hill with representatives from the State Extension Services, Association of State Foresters, the Forest Service, and the Association of Commercial Nurseryman all in attendance, but ultimately, no agreement was reached. Some State Foresters were quietly resentful that they had not been consulted before Norris and Jones introduced their initial bills in the House and Senate.[351] Meanwhile, the Shelterbelt Project had no choice but to plan for complete liquidation. Of particular concern was how to care for existing belts that had already been planted. Project personnel were highly aware that if the existing belts were abandoned and not cared for, critics of the program would point to abandoned rows of dying trees as proof that they had been right all along and feared that experimentation of Plains planting could struggle to find funding in the future. The appropriations bill had severed the federal government's legal interest in the existing plantings and land owners were now free to do with them as they wished. As the Nebraska State Director for the Shelterbelt Project wrote: "the failure of these strips would serve as the finest kind of propaganda for those who are awaiting an opportunity."[352]

On July 11, 1936, the Shelterbelt Project was given its first life-line when the WPA announced $600,000 to continue Shelterbelt planting in an effort to create more relief work for laborers living in the Plains states. This money could be used to pay emergency relief workers to plant the seedlings that Congress had ordered given away. There was intense local interest in many Plains communities to have the project continued, and the worsening drought made emergency relief work a necessity in those communities. By the end of 1936, the WPA had allocated a total of $1,605,521 to the

Project.[353] The Shelterbelt Project continued to evolve under this new funding structure. The cooperative nature of the planting was expanded such that farmers routinely absorbed more than 60% of the costs. The planting area was also widened beyond the initial 100-mile-wide Shelterbelt zone. The Shelterbelt Project was also officially given the designation of "The Prairie States Forestry Project" from this point forward.[354]
In January 1937, Senate Bill 903, the "State Foresters Bill," was introduced into the Senate by Senator McNary. The bill would provide money for fire control, insect control studies, insurance studies, and extend the Extension Services. Ultimately, Representatives Norris and Doxey introduced companion bills that became the Norris-Doxey Cooperative Farm Forestry Act, which passed both houses of Congress and was signed by President Roosevelt on May 8, 1937.[355] The Cooperative Farm Forestry Act gave authorization for cooperation across states and territories for the development of farm-forestry and worked to appease private nurseries by prohibiting federal nurseries from allowing their stock to enter the private market. It also widened the scope of farm-forestry work beyond the Plains region, making it the bill more attractive to representatives from across the country. The bill authorized the Forest Service to plant shelterbelts from the 9^{6th} meridian to the 101st meridian and granted functional authorization to the Prairie States Forestry Project.[356]

Private employment dropped at unprecedented numbers during 1937, and as a result, federal security programs were expanded over the course of 1938. The number of WPA project workers nearly doubled over the course of 1937, from 1.4 million at the end of September 1937 to 2.8 million at the end of June 1938.[357] Initially, the Forest Service requested $500,000 for the Prairie States Forestry Project in 1938 alongside funding

requests for other farm-forestry projects, but found they had to go through the Subcommittee on Deficiencies of the Committee on Appropriations hearings to do so. Though they had the approval of Congress, the House Committee on Appropriations determined that the long-term nature of any results from the Prairie States Forestry Project meant that there was no urgency to fund it. The Committee declined to fund the program, instead pointing toward the WPA funding the program had received and suggesting that was adequate. The Prairie States Forestry Project would be able to try later on for inclusion in the budget for the fiscal year 1939. After another round of back-and-forth in the House and Senate, wherein Senator Bilbo of Mississippi attempted to restore funding for the entire Cooperative Farm Forestry Act, but the strong dissent in the House led to the Senate-House Conference Committee to get rid of the amendment. Ultimately, Roosevelt was forced once again to direct just under $2,000,000 to the program from WPA funds for the year 1938.[358]

When it again came time for a budget request for the fiscal year 1939, the Forest Service asked for $2,500,000 to fund the Cooperative Farm Forestry Program, of which $1,000,000 would go to the Prairie States Forestry Project. The Budget Bureau decreased the funding line down to $1,200,000 but altered the proportion of spending such that $1,100,000 was allocated to the Prairie States Forestry Project, with only $100,000 allocated to fund the rest of the Cooperative Farm Forestry Program. This work by the Budget Bureau again opened up the Prairie States Forestry Project to criticism in Congress. As the House Committee on Appropriations wrote, "the proposed expenditure is not in accord with the purpose and intent of Congress under the Norris-Doxey Act,"

again eliminating the proposed funding for the Prairie States Forestry Project and leaving only the $100,000 intended for Cooperative Farm Forestry programs.[359]

Once again, a Senate amendment to the appropriations bill was attempted, this time by Senator Norris. He attempted to restore the full appropriations amount to $1,300,000, with the clarification that the Prairie States Forestry Project would not receive more than 20% of funds annually. However, even that was too much for the House to take, as the House conferees threatened that the entire bill would fail if the amendment was not removed from the Senate Bill.[360] However, the Subcommittee on Deficiencies once again was willing to hold hearings on the funding request. This time testimony was able to include the high survival rates of trees that had been planted and the near-universally positive reaction of local farmers to the project. In early 1939, Congressman Karl Stefan testified in front of the subcommittee for Agricultural appropriations and made his case for the continuation of the Prairie States Forestry Program. In a letter he sent to Paul Roberts, he described his efforts as "[making] some hay," and recounted that he felt he had impressed some members of the committee and expected at least partial funding. In a March 11, 1939 letter to Paul Roberts, Stefan reported that he had testified in front of the sub-committee for Agricultural Appropriations that, in his opinion, they had finally secured the support of local nurserymen, who were no longer operating in opposition to the project. The Subcommittee on Deficiencies ultimately decided that there was no emergency circumstance to justify placing the funding request into the bill. Once again, the House of Representatives was able to block funding, and once again, President Roosevelt provided funding to the project through WPA funds for the fiscal year 1939.

1940 Shuttering of Program

For the fiscal year 1940, the Prairie States Forestry Project did not even attempt to request funding through Congress, instead relying on continued support through the WPA. However, as WPA funds began to wane, the Forest Service decided to seek $500,000 for 1941 to fund administrative costs, allowing the project to otherwise scale up or down in size depending on the funding the WPA could provide. After the Budget Bureau denied requests for funding, the Department of Agriculture turned to Roosevelt. In May of 1940, Roosevelt directed that the Prairie States Forest Project get phased out as a project of the Forest Service and become the work of the Soil Conservation Service. The Prairie States Forest Project would be funded with WPA funds for 1941. No immediate steps were taken to absorb the project into the Soil Conservation Service, but continued WPA restrictions and the drying up of emergency relief labor were slowly constricting the project.

In March of 1941, Senator Norris of Nebraska asked the Appropriations Committee for a $300,000 addition to the annual Farm Bill to fund shelterbelt expansion. Norris displayed photographs and film to demonstrate that additional plantings were working and argued that his amendment was valid under the 1937 Norris-Doxey law, which authorized cooperative woodland plantings between the federal government and states or individuals. According to the Associated Press, many legislators were "astonished" to find out that the Shelterbelt Project had continued for years on emergency funds after they voted to liquidate the project back in 1936.[361] Representative Cannon from Missouri, the legislator who was in charge of the House subcommittee that handled the bill in 1936, voiced protestations that Congress had

already discontinued the project. However, the Earle H. Clapp, chief of the Federal Forest Service, pointed out that the project had been running on funds allocated from the WPA, and that the $170,000 given to liquidate the project back in 1936 was never used, and was instead returned to the Treasury. Representative Karl Stefan testified in the House of Representatives in favor of adding funds to the Department of Agriculture's appropriations bill to help fund the Prairie States Forestry Project, calling it a "meritorious project." Stefan argued that he had seen the benefits of the Prairie States Forestry Project in his home districts, citing protection for farm homes and wildlife, better crop yields, protection against soil erosion, and "happiness, comfort, and welfare" for farmers.[362] As part of his testimony, Stefan referenced a questionnaire set up by the Nebraska State Director, who had mailed out 2,335 questionnaires across 23 counties to get a sense of the efficacy of the program in his state. He received 313 responses. In his testimony, he read aloud 29 excerpts from the responses he received, representing farmers from Antelope, Madison, Knox, and Holt counties. All of the responses he read expressed positive reactions to the Shelterbelt program, with one farmer (Charles Wagner of Oakdale, Nebraska) calling the program a "godsend for the country" and another (Alfonse Beelaert of Orchard, Nebraska) saying "I believe shelterbelts are the finest work ever done for the farmer."

Though it faced continued resistance in from the House, the appropriations bill managed to pass both legislative chambers, giving the program its first-ever legislative funding of $218,100. Cannon, one of the program's staunch opponents in the House, wrote to Representative Karl Stefan that the final appropriation was due "very largely to the good services of [Stefan] and the other members of the Nebraska delegation. The rest

of us who were less familiar with the merits of the proposition were in doubt about it but followed your good judgment in the matter." Stefan sent a copy of Cannon's letter to Director Paul Roberts, noting that he was working to secure personal relations with those on the Committee:

"A lot of the boys here are still gasping at the way we put that appropriation over. I don't want anything to happen to it now, Paul, and I am making friends with these boys because I want them on our side when we bring up the next appropriation bill. We will just have to have our public relations such as to eliminate most of our future opponents. I am so happy we are having such fine growing weather and that ought to make our shelterbelt loom up. I hope to see the day you become chief of our Forestry Service as I know of no one in the service more qualified than you are."[363]

Stefan kept his word, giving remarks about the Prairie States Forestry Project in the House of Representative as late as December 1941. Despite the program's sudden success with Congress, with WPA labor supply drying up and emergency relief funds disappearing, the project was facing existential difficulties. Attention nationwide was shifting away from relief efforts and more toward defense. As Representative Stefan wrote to Paul Roberts in October of 1941, "I am anticipating quite a fight against all non-defense activities when our regular budgets come in…right now all they are talking about in Washington is the war and our probable active participation therein. I spend a lot of sleepless nights worrying over that." Paul Roberts wrote in reply, in December of 1941:

"As long as the war is on I expect that we should adjust our program to war time needs. I think that we should keep a nucleus of a trained organization together and some nurseries so that we can operate on an expanded basis when necessary after the war – if and when. There are some things, of course, we can do which will help in maintaining stabilized agriculture, which in itself is important during the war effort."
[at bottom in handwriting: I'm ready to go anywhere and do anything I can"][364]

Just days later Stefan replied, noting that he believed the WPA would be moving toward national defense as a priority. He wrote:

"In fact, the entire WPA in the East has been mechanized. In other words, relieved of pick and shovel and put to work on machines to get the job done fast. The East now is number one priority, so far as WPA is concerned; the West coast is number two; the Gulf coast is three and the middle west is the lesser priority…I am looking for a lot of changes to be made within the very near future. But we must realize, Paul, everything is now in confusion and we are in the war. All of us must get behind the Administration in order to win."[365]

This sentiment seemed to echo across government, as non-defense programs moved to the back burner. A new Secretary of Agriculture, Claude Wickard, decided it would be best to transfer the Prairie States Forestry Program to the Soil Conservation Service effective July 1, 1942. The transfer of the Prairie States Forestry Program effectively ended it, with project personnel being assigned new working assignments. In the end, a net total of $13,262,250 was spent on the Shelterbelt Project, a mere fraction of the original $75 million-dollar budget. Another estimated $4,641,197 was donated to the project through the fencing and care of shelterbelts by farms, and the supplies, equipment, office space, and other services that were directly donated by volunteers and local, city, and state governments, in service of the project.[366]

Despite the uphill battle the Shelterbelt Project faced with academics, foresters, and the United States Congress, it found nearly unanimous support from local farmers in the Plains region. As Roberts stated, "the thrifty tree belts, soon appearing and often the only green things in a countryside, brought a renewed faith in the land and hope for the future."[367] Though the project plans originally called for the purchase of private lands, by 1936, the Shelterbelt Project only planted trees on farms in cooperation with the landowner. As of May 1936, the Forest Service had received more requests for trees than it had available seedlings.[368] For C.P. Barker of Sweetwater, Oklahoma, shelterbelt plantings in 1935 seemed to pay off just two years later - his fields in the protection of the

shelterbelt were able to produce three-fourths a bale of cotton per acre, whereas a neighbor with no shelterbelt protection found nearly all his crops destroyed by wind. Dr. A.H. Bungardt of Cordell, Oklahoma, actively sought out Forest Service assistance for his farm. After plantings of cotton-woods and Chinese elms, Dr. Bunghardt declared that his crops were "never better" and that his land overall "has shown a steady improvement since trees began to grow. E.A. Kirk of Magnum, Oklahoma came to consider himself among the converted. Though he "didn't think much of this tree business when [it] first started," he was one of the first in his area to accept shelterbelt plantings and became "convinced…that if we had a shelterbelt across every section of land in Western Oklahoma, our troubles from wind erosion and crop blowing would be over.[369]

An article in The New York Times from June 1939 declared the advocates for the Shelterbelt Project a success, describing photographs of "barren, wind-swept farmsteads of 1935, the swirling topsoil piled, use-lost and waist deep" replaced today by photos of the same farm "four years later, with thirty-foot heights of greenery from twenty to 100 feet wide sheltering picnickers eating watermelon which grew equally sheltered, where nothing would grow before." A New York Times survey found that farmers who had received shelterbelts declined to even put a monetary value on them, one saying that "for comfort and pleasure alone they are worth more than dollars and cents," with their benefits ranging from protecting livestock, reductions in household fuel costs, and protection of crops, buildings, and orchards, from blizzards and wind. All told, results on the ground were never able to supplant the furor of the storm of criticism the project faced in its opening days, with legislators instead continually moving to block or lesson federal funding for the project.

Chapter 8: Digitizing the Great Plains Shelterbelt

Introduction

One of the challenges in studying the Shelterbelt is that its diffuse location is described in broad terms. The nature of the planting – on private property over six different states – makes it difficult to talk with specificity about where plantings occurred. The archival record also holds few comprehensive clues, though National Archives records relating to the Shelterbelt Project contain a couple local planting maps. In an effort to produce estimate the density project plantings, I undertook the digitization of Shelterbelt plantings as represented on United States Geologic Survey (USGS) Topographic Map Quadrangles. This effort resulted in a digital estimation of the concentration of Shelterbelt plantings across Zon's Shelterbelt zone, allowing for the creation of models to estimate which factors may have been most effective in driving planting concentration.

Digitizing the Shelterbelt

Throughout the archival work carried out for this project, an initial hope was to find a substantial number of project maps detailing planting locations. However, a search of the National Archives holdings in Kansas City turned up just one map of planting concentration areas in Hall County, Texas. A subsequent search of the Nebraska State Historical Society's archives revealed a similar map of a section of Antelope County, Nebraska. The map showing plantings for Hall County, Texas map is dated 1937, while

the map for plantings in Antelope County ranges in time from 1935 “planted” sections to 1940 “planned” sections. Unfortunately, due to the Antelope County map being a black and white photocopy, the difference between “planned” and “planted” sections on the map is obscured through the loss of the original color variation.

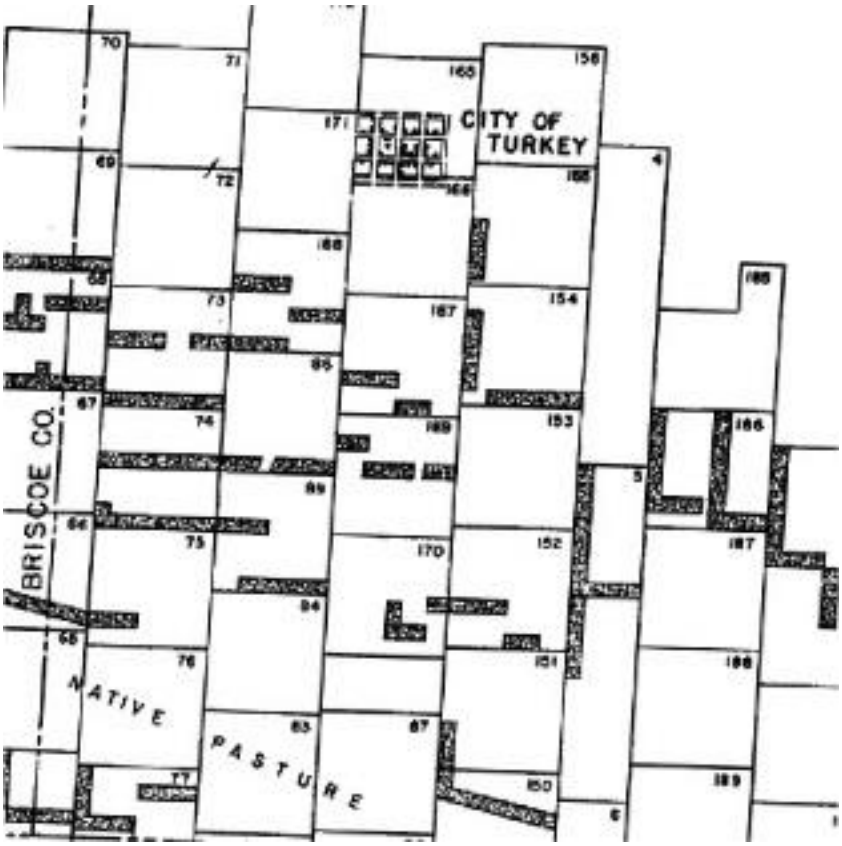


Figure 9: “1937 Concentration Area, Hall County, Texas”[370]

These two maps confirm that plantings were fashioned in straight corridors, often following east/west or north/south section lines and give a sense of the scale at which plantings were carried out. For reference, even many of the short Shelterbelt lines on these maps measure out to approximately half a mile long. Taken together, the planned Shelterbelts on the map of Hall County dwarf the town of Turkey, Texas.

The Cartographic Records Division of the National Archives in College Park, Maryland have in their holdings a 1941 map which provides the most definitive set of Shelterbelt planting boundaries I was able to find (**Error! Reference source not found.**). These boundaries extend beyond Zon's initial Shelterbelt zone, and for the purpose of this analysis, are used as the official project boundaries. The map shows planting areas of "high concentration," though the color quality of the scanned mapped makes some of these areas difficult to discern.

To get a more complete sense of the project's planting patterns and concentrations over the six project states, I digitized Shelterbelt features from USGS Topographic Map Quadrangles. Each 7.5-minute USGS (1: 24,000 scale) quadrangle map contains approximately 64 square miles and is fine enough in scale to make Shelterbelt features plainly visible. Each USGS Quadrangle map was produced by hand, and because of the painstaking level of detail and effort that went into the creation of each map, they were not produced uniformly across the United States at exactly the same time.

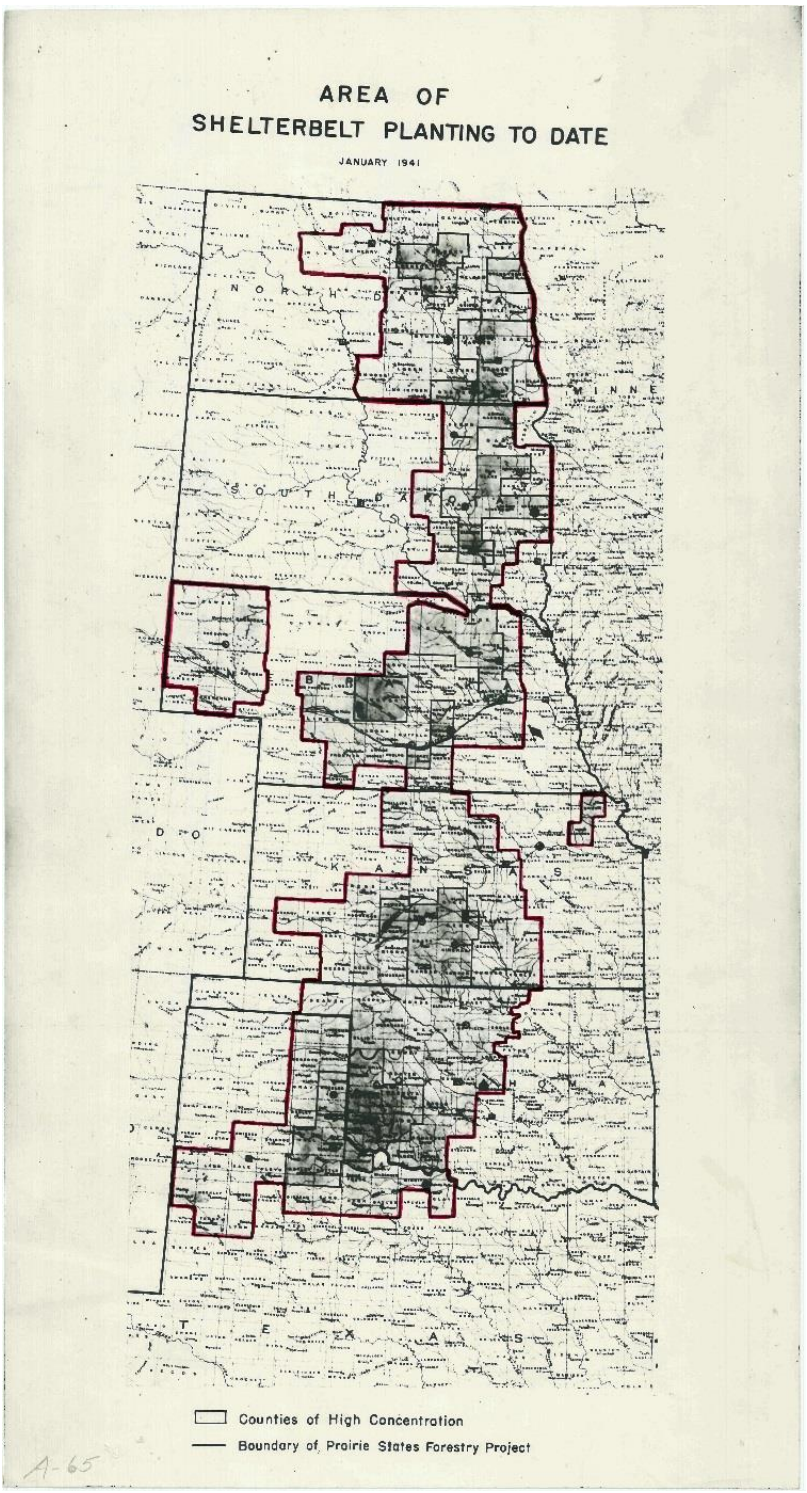


Figure 10: "Area of Shelterbelt Planting to Date January 1941"[371]

The New York Times describes the USGS Topographic Map series as a "heroic rendering of the American landscape…as gorgeous and complete a depiction of the

country as any ever made."[372] The quadrangles I was able to utilize ranged in production year from 1950 to 1975, as this was earliest and more uniform dataset available to me. Aerial imagery was not exhaustively produced for this area until relatively recently. Older aerial images do exist across the Shelterbelt zone, including some late 1930s imagery flown by US Government, but that imagery has not yet been widely digitized and doesn't exist uniformly across all six states. Given resource constraints, the best option was to digitize from USGS Topographic Maps, which are publicly available and can be downloaded individually in digital, spatially-referenced formats through the USGS' "topo View" online platform.

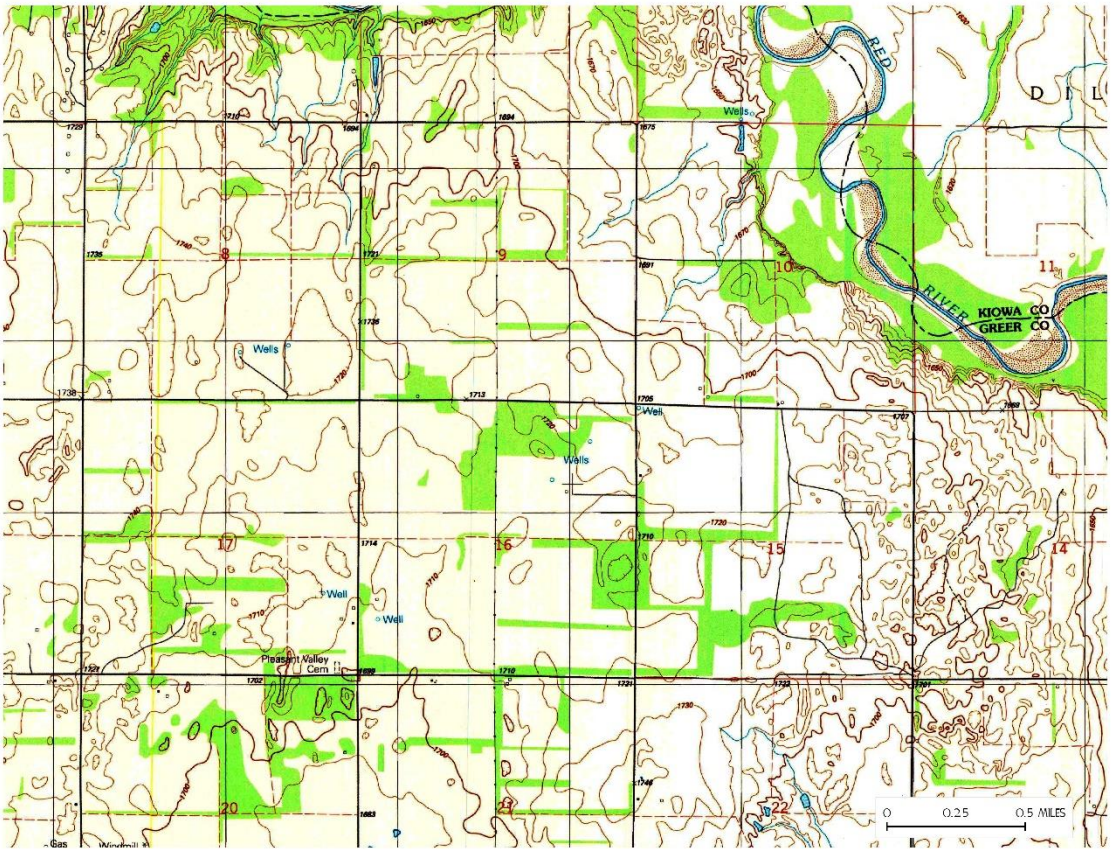


Figure 11: "Original USGS Quadrangle (Lake Creek, OK)"

The first step in the digitization process was to manually download all quadrangles which cover the study area. The Shelterbelt Project was spread out over 651 counties in six states, comprising a total of just under 12,000 quadrangles. The size of the project and the storage space and processing speed of my machine mandated that I complete the digitizing process in a series of smaller batches. First, the USGS quadrangles were downloaded as GeoTIFFs and organized in folders. I then utilized the software program 'FME Workbench' to transform the GeoTIFFs. Using FME Workbench, I extracted out only green (vegetation) features and converted them to vector shapefiles. I built a small model in FME Workbench which allowed me to batch process the files in groups.

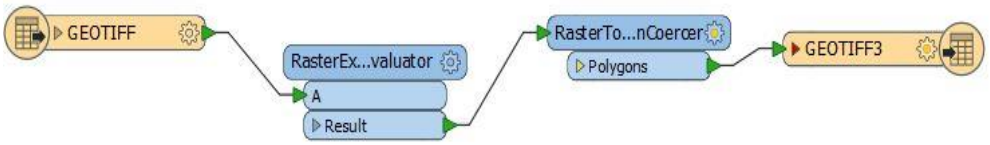


Figure 12: "FME Workbench Model"

In Figure 12: "FME Workbench Model", the individual USGS Quadrangle GeoTIFF image serves as the input file. The GeoTIFF is run through the "RasterExpressionEvaluator" where the interpretation for band Red8 was given the expression: *if (A[1]-A[0]>20 && A[1]-A[2]>20, 200, 255).* This expression identified only the sections of the GeoTIFF with a green color value. USGS quadrangles are uniformly color coded such that all green features are some variety of vegetation. In the next step, the raster runs through the "RasterToPolygonCoercer," which changes the selected sections of the raster into vector polygons. The final step of the model specifies an output name and location for the resulting shapefile. By extracting green features from the GeoTIFF, I was able to create a vector shapefile that contained only the shape of vegetative features in each quadrangle.

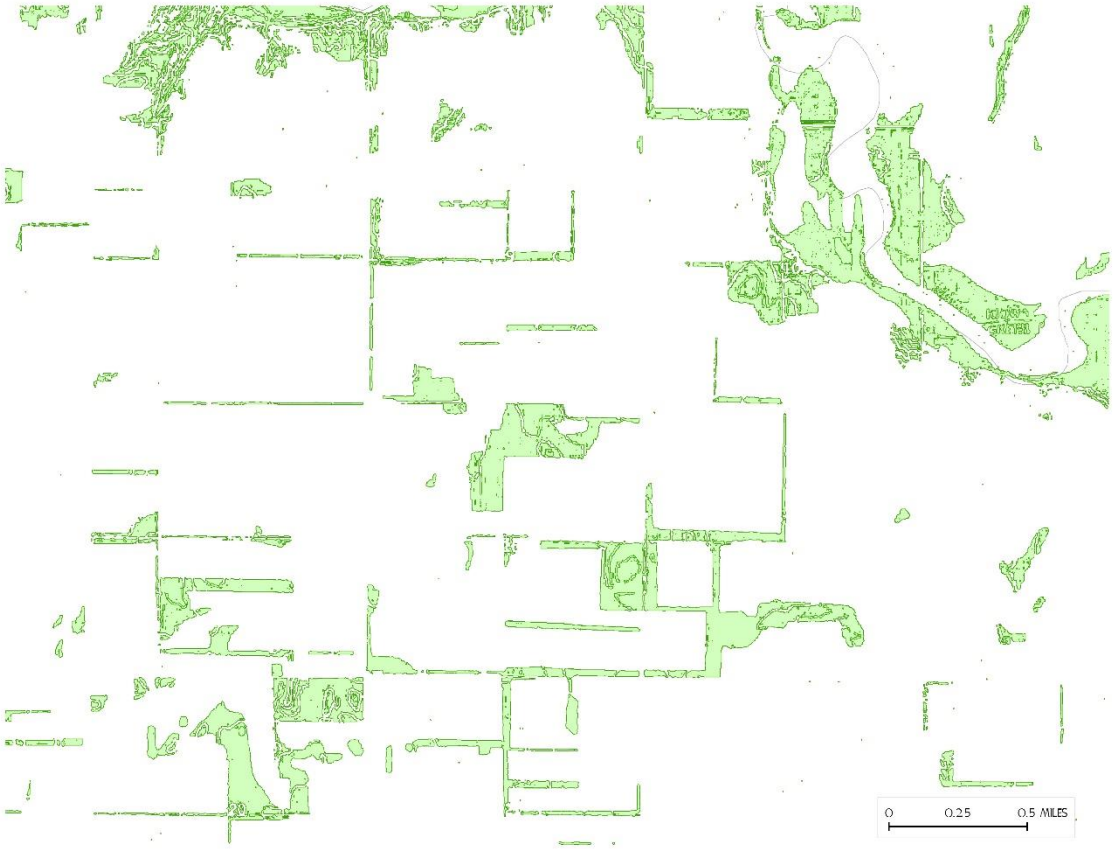


Figure 13: "Shapefile Output from FME Workbench"

The shapefile outputs were then opened in ESRI's ArcMap. In this particular case, what distinguished areas of Shelterbelt from other forested vegetative areas was the shape and scale of the plantings. As observed in planting concentration maps, Shelterbelt plantings are wide, linear features that run east/west or north/south, primarily along section lines. Using the output shapefiles of only the (green) digitized vegetation features from quadrangles, a manual method was employed to go through each of the resulting shapefiles and delete features that did not meet that descriptive criteria. In any cases of uncertainty, 2015 aerial imagery from ESRI's World Imagery base map was consulted to verify what type of vegetative feature was being displayed. This process was employed

for all quadrangles over the study area of counties that fell within the counties identified as receiving some amount of Shelterbelt Project plantings.

Figure 14: "Resulting Output Shapefile from FME Workbench"

Ultimately, all resulting shapefiles were merged together to create one master file. Given that the shapefiles were created based on GeoTIFF image files, the quality of the output vector shapefile was dependent upon the image and coloration quality of the scanned USGS quadrangle map. As a result, some of the output shapefiles were quite fragmented, either appearing with many small parts in what should have been one large feature, or in some cases, features were left with jagged edges. This fragmentation resulted in the vectorized area being smaller than the comparative vegetation feature on the original quadrangle. In

order to resolve this issue, all polygons within 100 meters of one another were aggregated together, and then a further 15m buffer was applied and dissolved within each feature. This aggregated the fragmented features and resulted in restoring smooth lines to the belts.

Figure 15: "Output Shapefile with Aggregated Polygons"

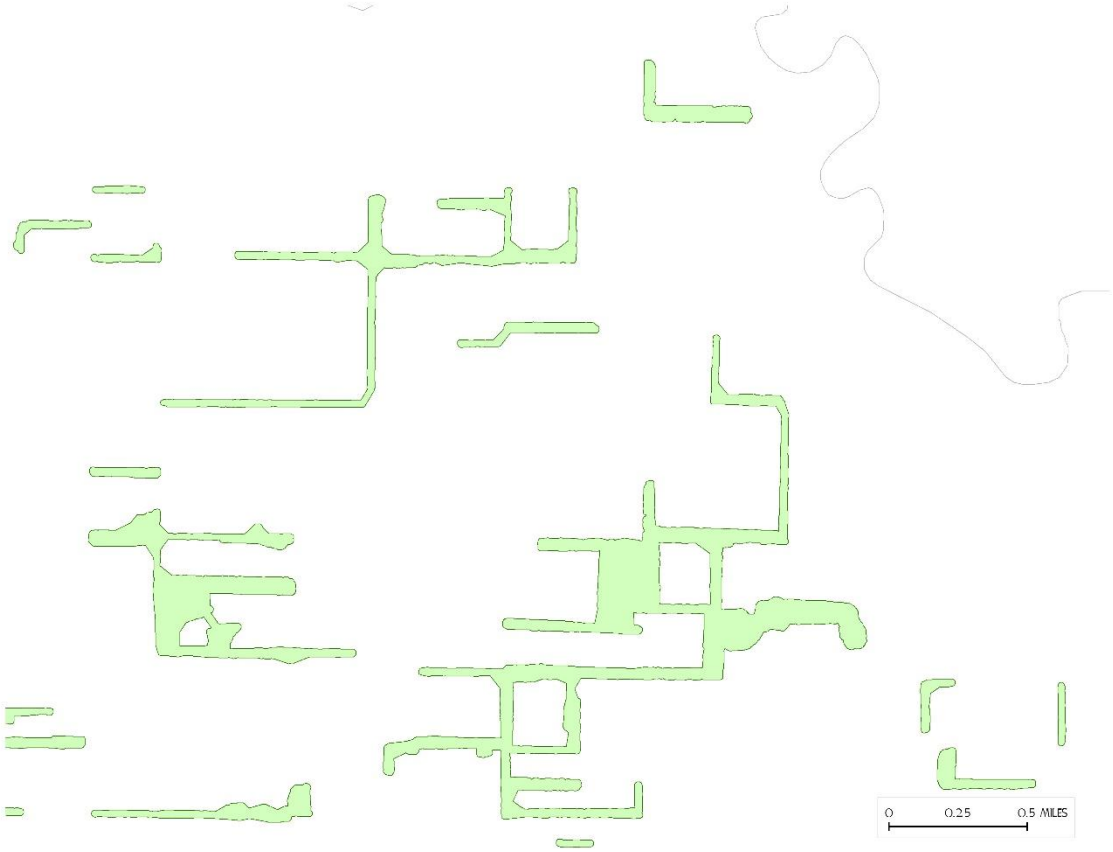


Figure 16: "Output Shapefile with 15 meter buffer applied"

The resulting vector shapefiles are considered the final result for digitizing Shelterbelt lines. Calculating an area for each belt in acreage allowed for the compilation of estimated digitized acreage numbers for each county.

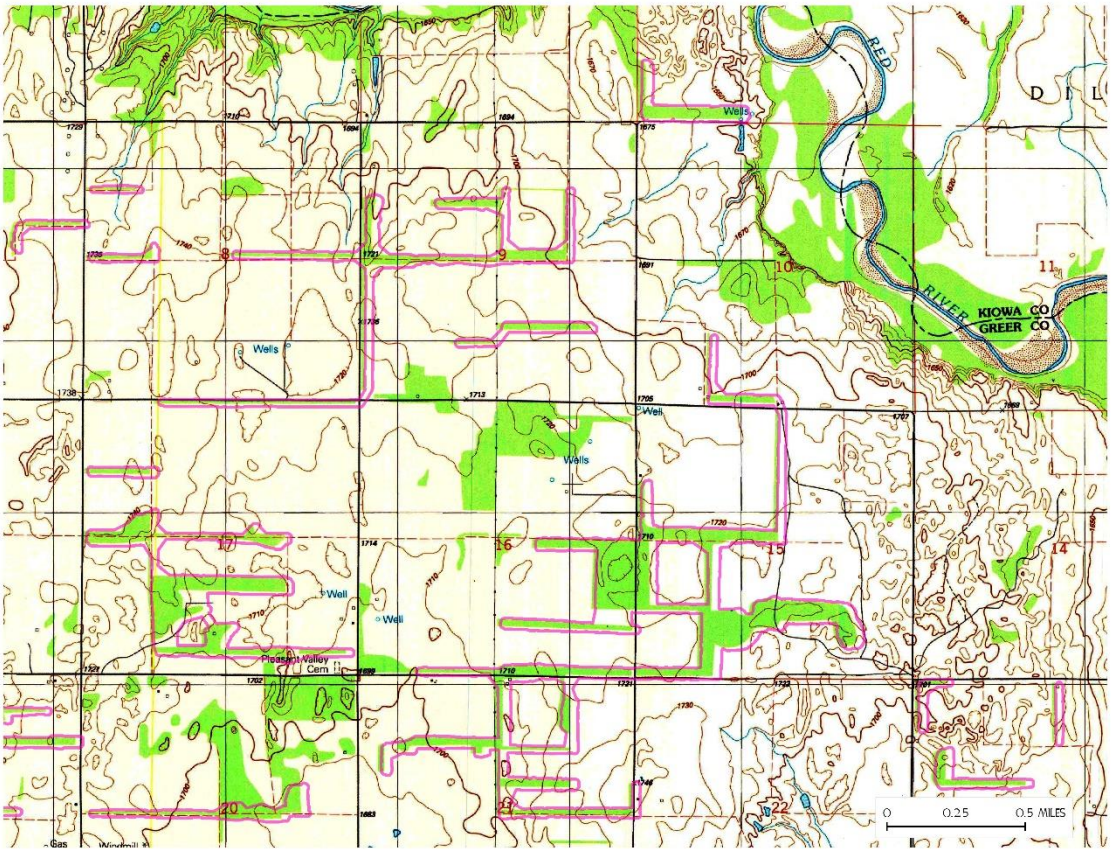


Figure 17: "Original USGS Topographic Quadrangle with Digitized Outlines"

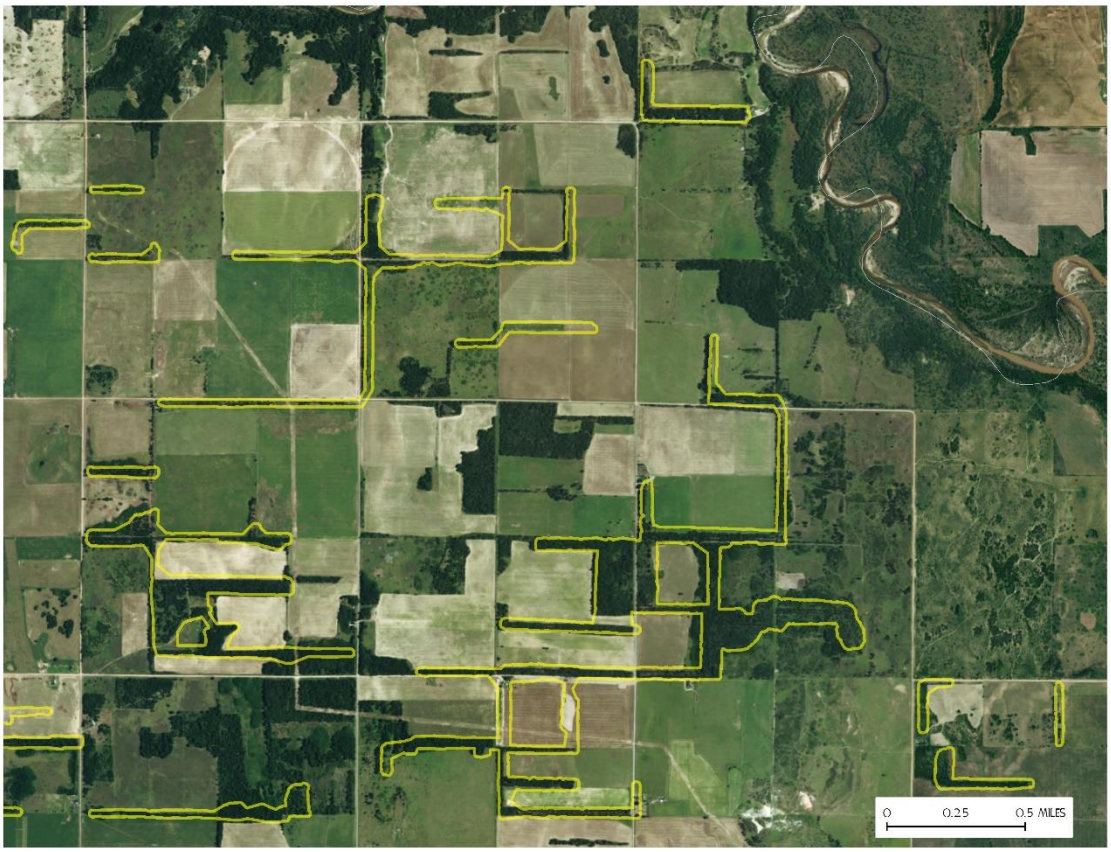


Figure 18: "Final Digitzed Outlines Over 2015 Aerial Imagery"

State	Digitized Acres (Shapefile)	Official Project Acreage Totals	Digitized Acres as Percent of Official Numbers
Texas	22,589.08	26,053.00	86.7%
Kansas	44,457.27	44,493.00	99.9%
Nebraska	52,024.09	51,621.00	100.7%
North Dakota	47,737.72	34,711.00	137.5%
Oklahoma	37,073.66	37,117.00	99.8%
South Dakota	43,180.98	44,227.00	97.6%
Total	247,062.80	238,213.00	103.7%

Figure 19: "Digitized Shelterbelt Acreage and Official Project Totals"

The final acreage numbers for the digitized Shelterbelt track closely to the official acreage numbers pulled from Shelterbelt Project records, the most notable exception being North Dakota, which has a much higher number of digitized Shelterbelt acres than should exist according to official project numbers. Despite how close these numbers appear, I would offer two cautions: the first being that the process of buffering and dissolving nearby Shelterbelt segments in the digitizing process to aggregate shattered polygons has inevitably resulted in a very slight inflation of digitized acreage totals. Additionally, while the attempt to filter Shelterbelts based on scale would rule out very small shelterbelts (for example, trees planted only along the side of a house), this digitizing work has inevitably captured shelterbelts that were not officially created as part of the Shelterbelt Project and were instead constructed with private funds. Anecdotal reports have also noted that not all Shelterbelt plantings survived years after their initial planting and could have been gone by the time the USGS quadrangles were created one or two decades later. It is my estimation that the digitization efforts have slightly inflated

the microscale acreage of individual shelterbelts, and this number has been off-set by the disappearance of a small percentage of original Shelterbelt plantings that failed to thrive.

Figure 20: "Digitized Shelterbelt"

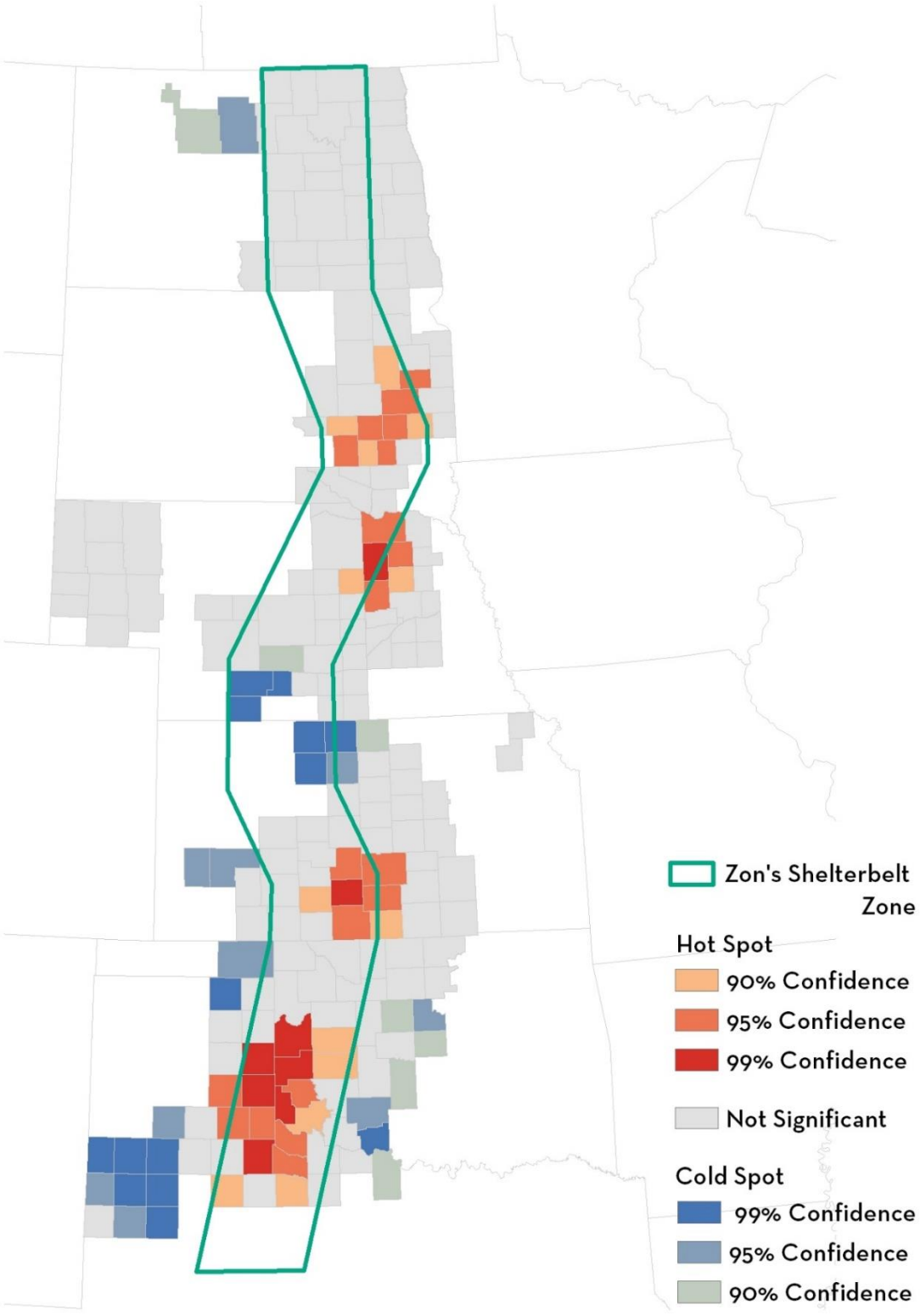


Figure 21: "Concentration Areas of Shelterbelt per Acre of Cropland"

Bates had a stated goal of completely even distribution of Shelterbelt plantings to achieve maximum benefits across the planting area and to ensure that "no individual or small group should benefit to the disadvantage of others."[373] However, the concentration of digitized shelterbelt indicates that the Shelterbelt Project did not evenly distribute plantings within the designated planting zones. To test whether or not the spatial clustering of Shelterbelt concentration is statistically significant (that is, more concentrated than what you would expect to find than if the same values were randomly distributed over space), I applied the Getis-Ord Gi statistical test. The Getis-Ord Gi test can identify "hot" and "cold" spots of statistically significant clusters given the weighted values of the Shelterbelt concentration figures (see: Figure 21: "Concentration Areas of Shelterbelt per Acre of Cropland). Spatial clustering of high values is produced by high z-scores and small p-values, while a low negative z-score and small p-value are indicative of a spatial clustering of low values.[374]

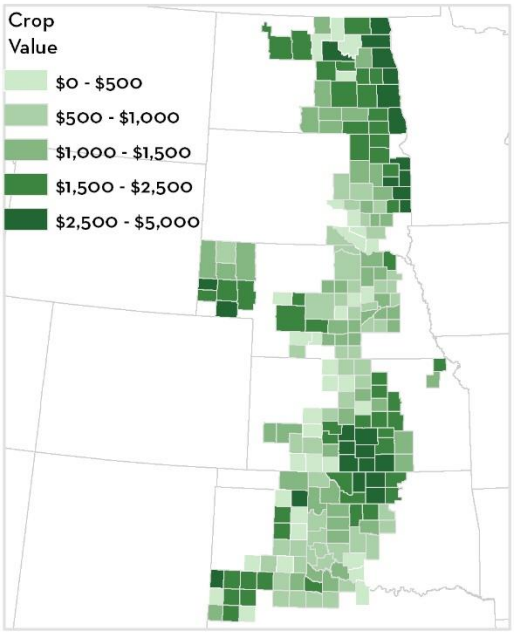
Using the results of the Getis-Ord Gi statistical test, I aggregated all areas with a statistically significant confidence rate of 95% (GI_bin values of 2 or 3) or above to create Shelterbelt concentration areas. This produced three concentration areas of contiguous counties for which there is at least 95% confidence level that they are statistically significant hot spots.

Modeling Shelterbelt Concentration

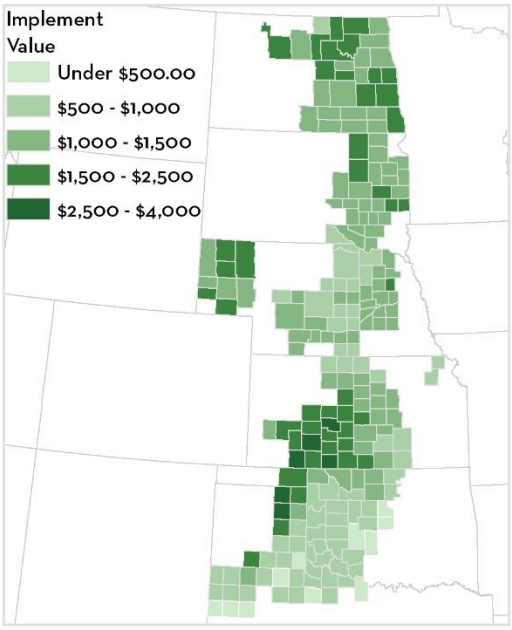
The debate over the Shelterbelt Project during the time of its conception and implementation was nominally over the science of tree planting. Critics of the project alleged that low precipitation levels and the soil quality of the Great Plains could not support widespread planting. The digitized Shelterbelt spatial dataset created through the

USGS digitization process allowed me to model which independent variables best predict ultimate Shelterbelt concentration, measured as the concentration of Shelterbelt acres per acre of 1930 cropland per county.[375] Using the digitized shelterbelt to model shelterbelt planting concentration gives insight into how much economic conditions, physical conditions, and access to project personnel ultimately factored into where project planting was most successful.

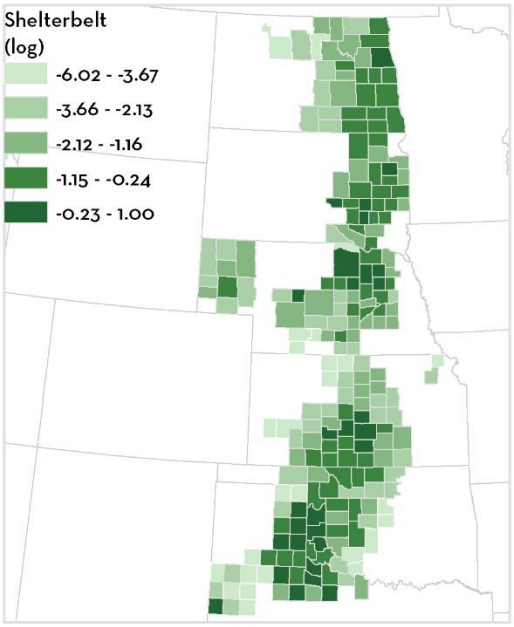
The first model demonstrates the economic power of each county using the total value of crops per county in 1929 divided by the number of farmers per county for 1930 (i.e. the average value of crops per farmer by county). Both metrics were taken from the 1930 census.[376] The second model is based on soil composition and precipitation rates, the main climatic features that Bates considered when mapping out planting zones for the project, and the key climatic determinants that many project detractors argued would not sufficiently support planting. Precipitation rates were sourced from the National Oceanic and Atmospheric Administration's National Center for Environmental Information, which provides downloadable Climatological Summary data. Precipitation data for 1933 was mapped, interpolated across the study area, and averaged on a per-county basis.[377] Soil composition was taken from the National Cooperative Soil Survey, produced by the United States Department of Agriculture's Natural Resource Conservation Service.[378] The final model is based only on proximity, using the measure of distance from the center of each county to the closest Prairie States Forestry Project State Headquarters office. This model represents physical access to project resources and personnel.



Average Crop Value per Farmer (1930)



Average Value of Implements per Farmer

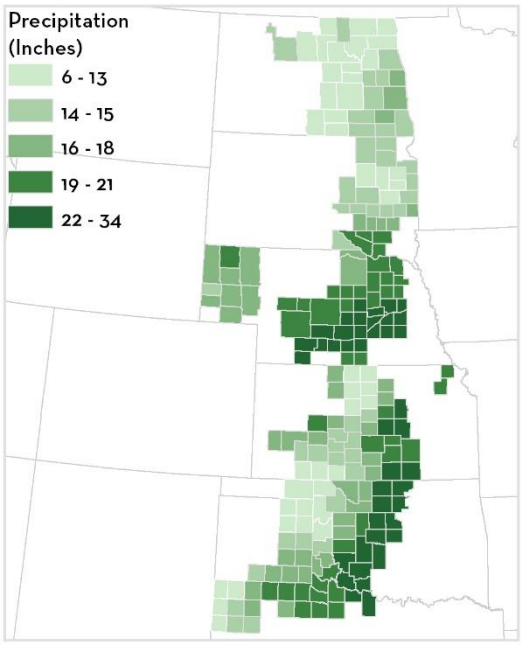


Shelterbelt as Percent of 1930 Cropland (log)

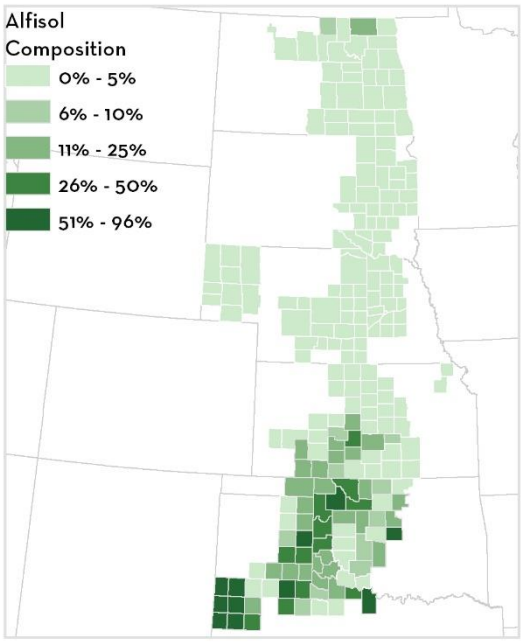
Economic Model Variables

0 200 400 Miles

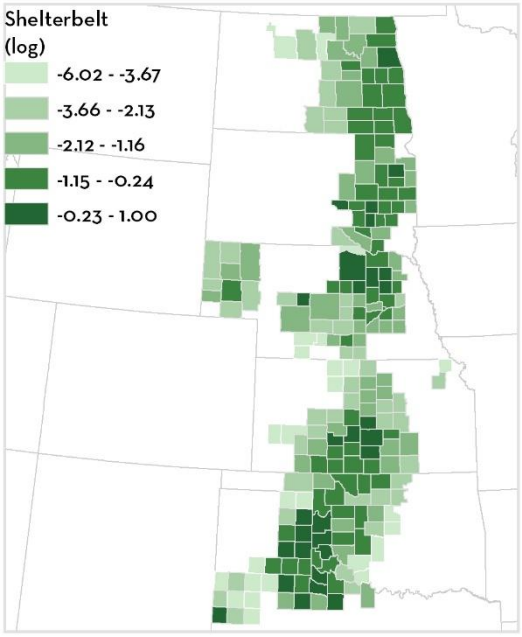
Figure 22: "Economic Model Variables"



Precipitation Rates, 1933



Alfisol Rate (Soil)

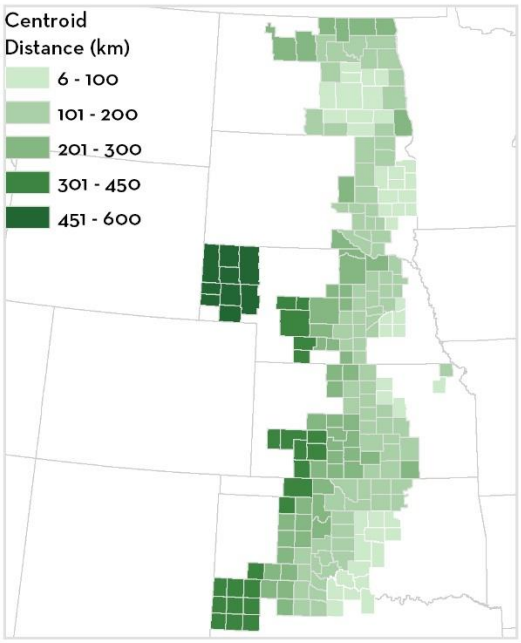


Shelterbelt as Percent of 1930 Cropland (log)

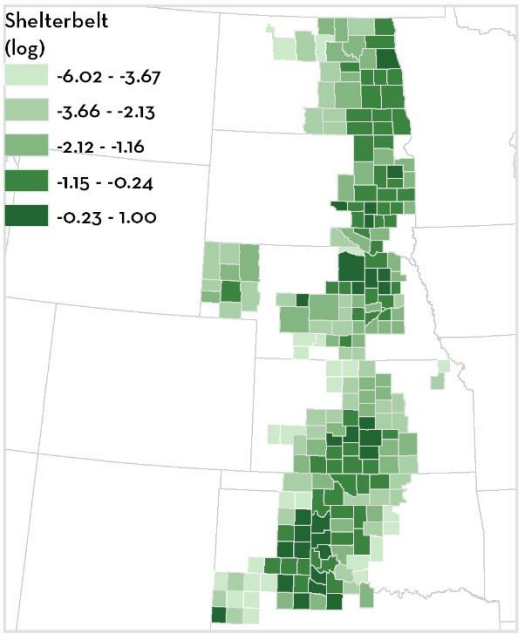
Physical Model Variables

0 200 400 Miles

Figure 23: "Physical Model Variables"



Distance from Center of County to Closest HQ Office (KM)



Shelterbelt as Percent of 1930 Cropland (log)

Distance Model Variables

0 200 400 Miles

Figure 24: "Distance Model Variables"

I ran Ordinary Least Squares on each of the three variable sets (for full OLS results, see Figure 25: "Ordinary Least Squares Results"). Ordinary Least Squares can be used to model linear relationships between explanatory variable(s) and a dependent variable.[379] The OLS coefficients indicate the strength and direction of the relationship between the dependent and explanatory variables. The coefficient of the economic model indicates that as the average value of farm implements per farmer increased, there were fewer Shelterbelt plantings, but in areas where the average crop value per farmer were higher, there were more Shelterbelt plantings. The physical model indicates that areas with less annual precipitation and less than ideal soil types were more likely to see Shelterbelt plantings. The physical model results may back up Zon's argument that the existing agricultural economy present in the Shelterbelt zone was capable of supporting tree planting in all areas, but that including areas typically used for grazing, as it was in these areas that trees could do the most work to "stabilize this agriculture and leave it less at the mercy of the elements."[380] The distance results indicate a very slight negative relationship between proximity to State Headquarters and Shelterbelt planting concentration.

The Variance Inflation Factor (VIF) is a measure of redundancy between variables, and values around 7.5 or above are considered a sign that one or more variables may need to be removed or replaced.[381] Both the economic and physical models, which have multiple variables, have acceptable VIF scores. The Jarque-Bera diagnostic indicates a bias model if the returned value is statistically significant. In this case, both the economic and physical model are indicating some bias. A Koenker p-value of less

than .01 indicates that the relationship being models exhibits statistically significant nonstationarity, which both the economic and physical model indicate.

Variable	Coefficient	Standard Error	Probability	VIF	Robust Pr
Farm Implement Value	-.00009	.00019	.604	1.021	.657
Crop Value	.00025	.0001	.0233*	1.021	.030*
Distance	-.000003	.000001	.0009*	N/A	.0010*
1933 Precipitation	-.0403	.023	.082	1.007	-1.66
Alfisol Soil	-.0015	.0054	.772	1.007	-.213
	Multiple R Squared	**Adjusted R Squared**	**AICc**	**Jarque-Bera p-value**	**Koenker p-value**
Economic	.024	.015	774.81	0.000059*	0.011441*
Distance	.050	.046	766.907	0.053758	0.000373*
Physical	.014	.004	777.004	0.000047*	0.003100*

Figure 25: "Ordinary Least Squares Results"

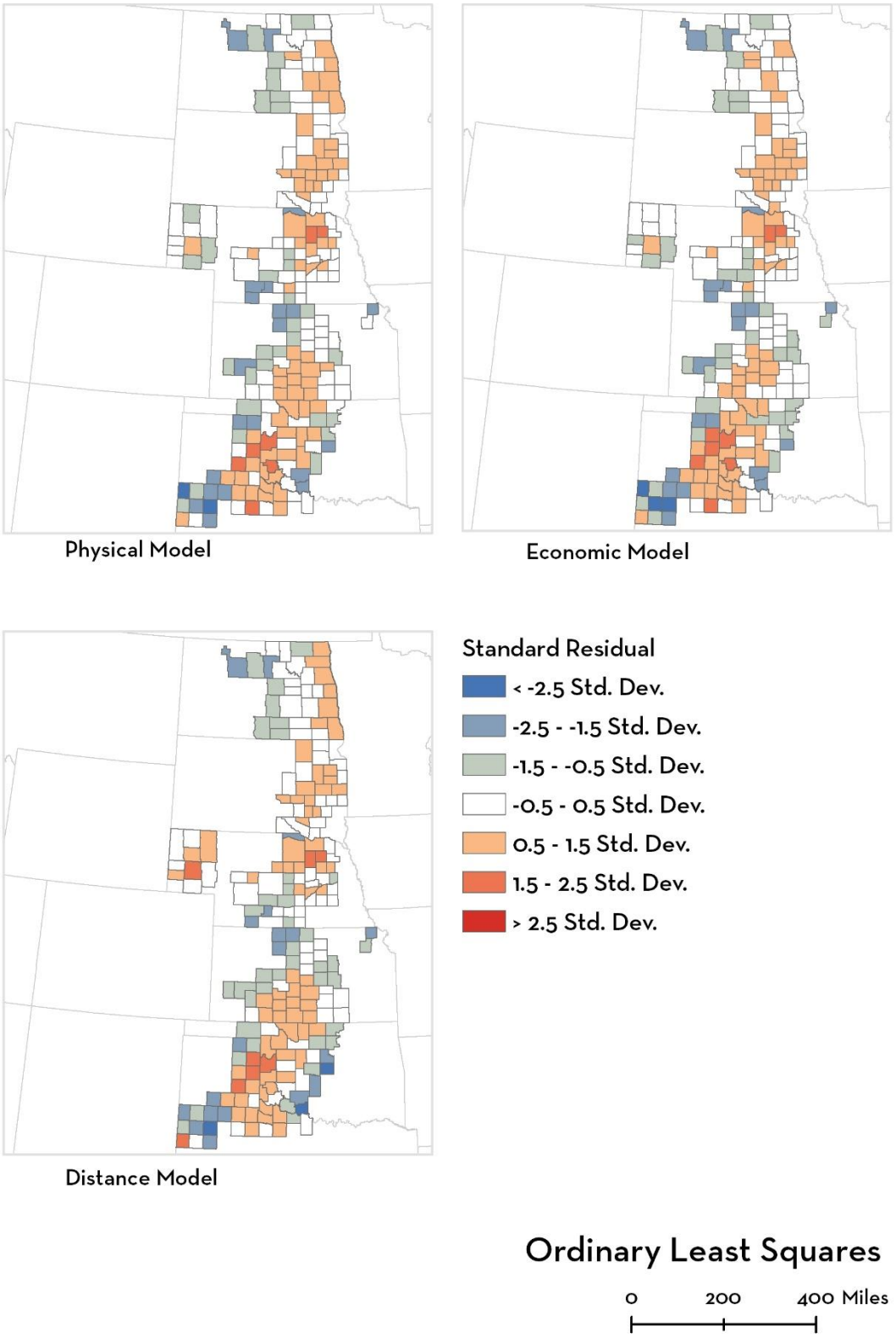


Figure 26: "Ordinary Least Squares Standard Residuals"

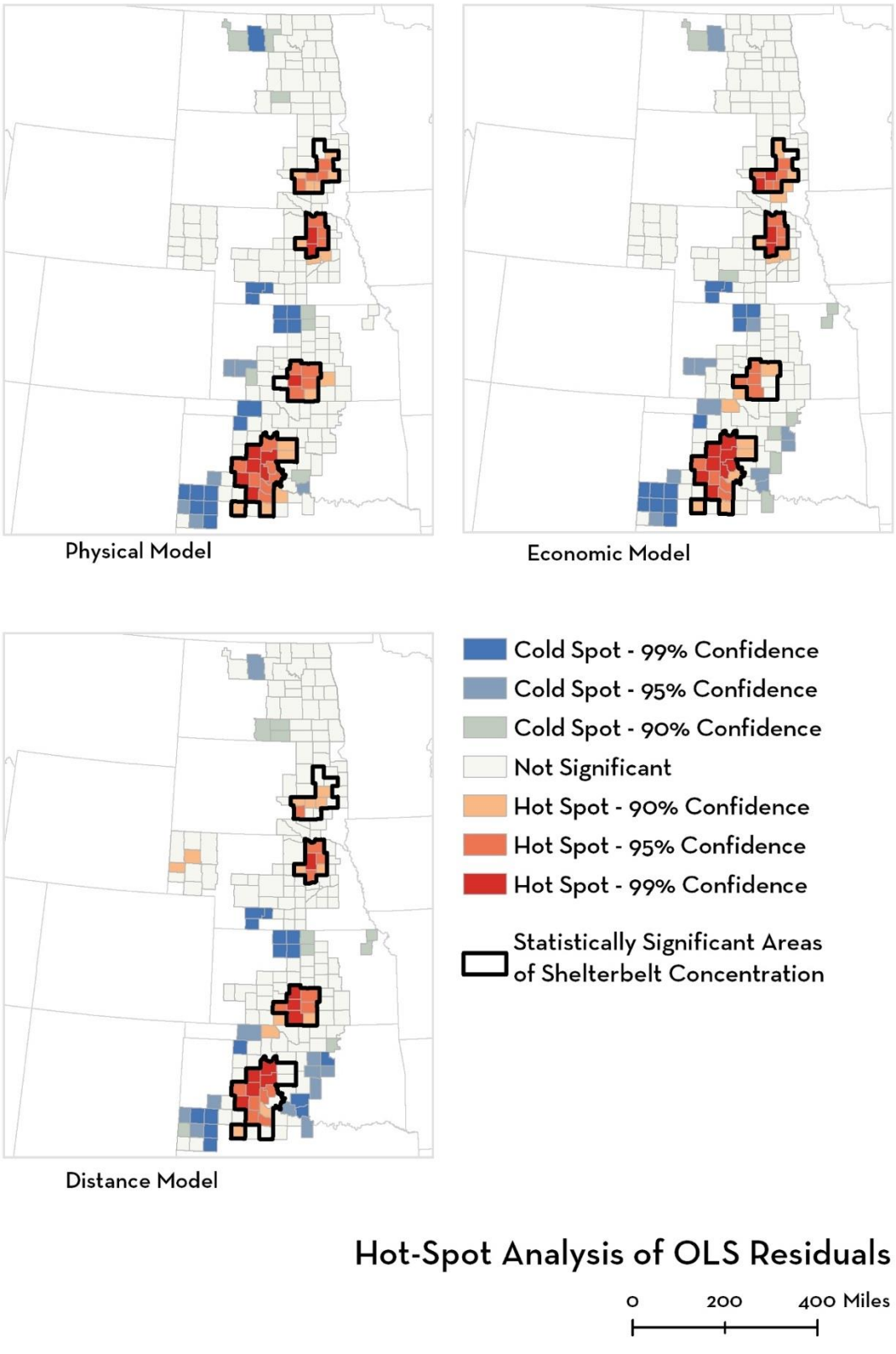


Figure 27: "Hot-Spot Analysis of OLS Residuals"

In order to more fully explore the potential model bias and nonstationarity, I ran a Hot Spot Analysis on the OLS residuals (see Figure 27: "Hot-Spot Analysis of OLS Residuals"). This revealed a clear spatial pattern of clustering around the areas where Shelterbelt planting concentration itself was statistically significant. I then ran a Geographically Weighted Regression (GWR), which allowed me to explore the potential that the bias of the variables as reflected in OLS was a result of spatial nonstationarity. GWR creates local models of variables by fitting regression equations to each feature of the dataset.[382] Full results can be found in Figure 28: "Geographically Weighted Regression Results" The best fitting model turned for predicting shelterbelt concentration according to the GWR analysis is the economic model, which returned an R2 value of .709. R2 measures the goodness of fit of a model and represents "the proportion of dependent variable variance accounted for by the regression model."[383] This is to say that an estimated 70% of the variance of Shelterbelt planting can be explained by proximity by the average crop value for farmers per county and the average farm implement value per farmer by county.

	Economic Model	**Physical Model**	**Proximity Model**
Variable(s)	*Average 1930 Crop Values per Farmer* *Average Farm Implement Value per Farmer*	*1933 Precipitation Rates* *Alfisol Soil Composition*	*Distance to closest Prairie States Forestry Project State Headquarters Project Office*
Residual Squares	133.9	288.69	206.47
Effective Number	71.03	21.388	39.98
Sigma	.967	1.224	1.09
AICc	655.25	709.17	671.61
R2	.709	.37	.55

Figure 28: "Geographically Weighted Regression Results"

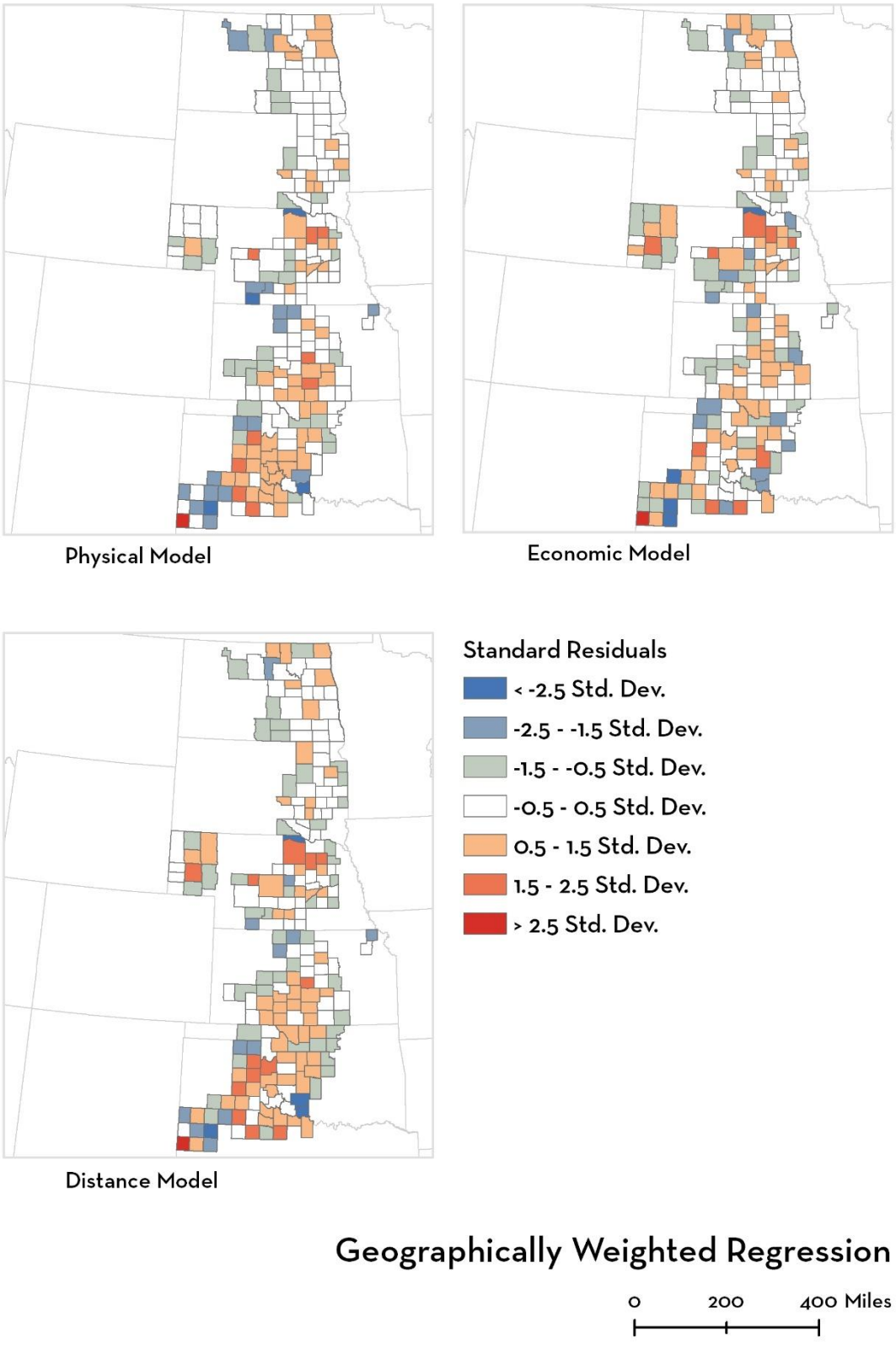


Figure 29: "Geographically Weighted Regression Standard Residuals"

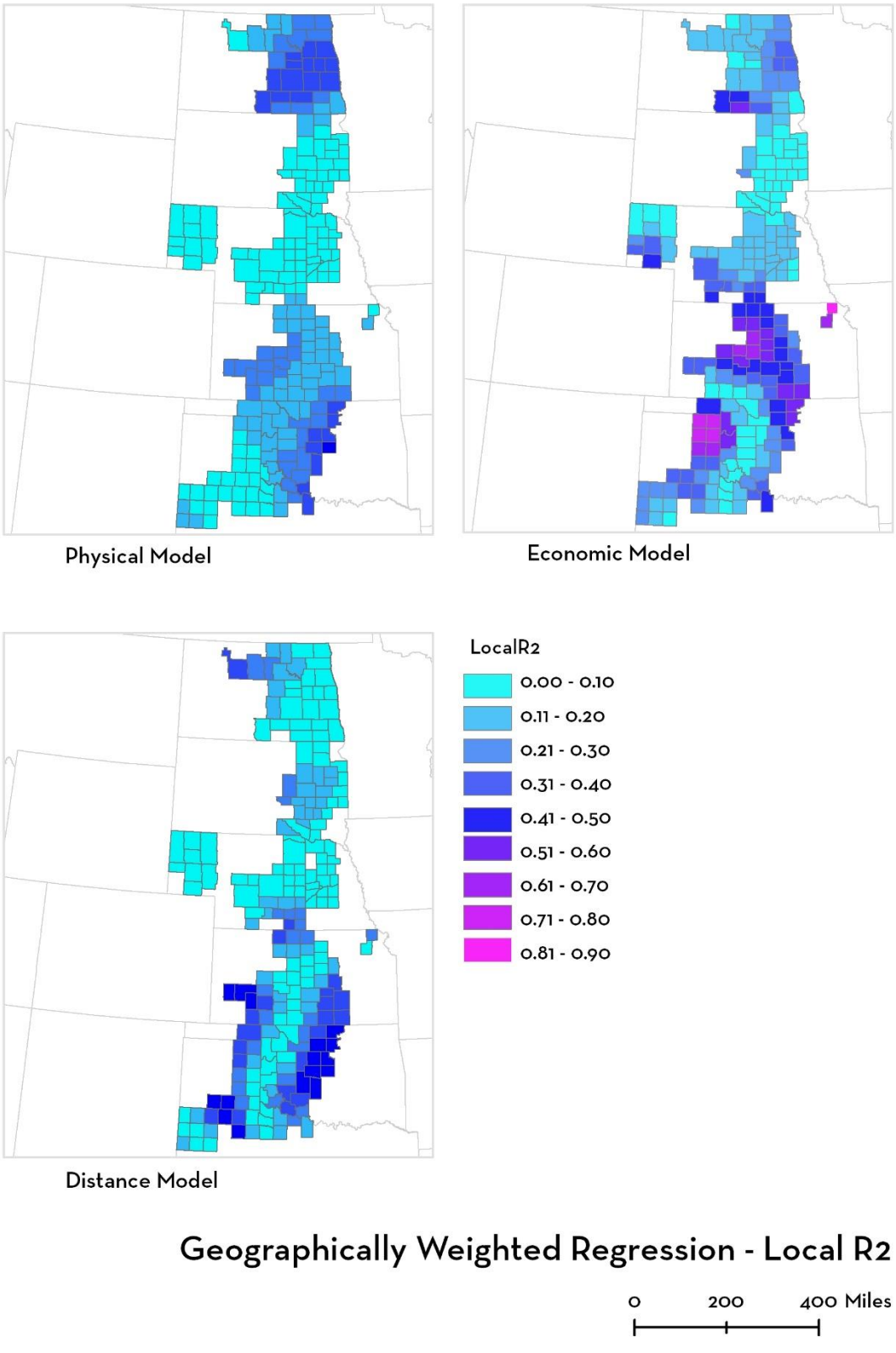


Figure 30: "Geographically Weighted Regression Local R2 Values"

Mapping the Local R2 values for each GWR analysis gives us insight into where these models were most effective across the Shelterbelt planting area. The distance model performed best on the eastern and western-most areas of Kansas and Oklahoma, western North Dakota, and north Texas. The physical model performed best in North Dakota, Kansas, and Oklahoma. The economic model performed best in areas of all states except South Dakota, with the highest Local R2 values along the Texas-Oklahoma border and large sections of Kansas.

These regression results indicate that although project critics questioned the physical feasibility of planting, economic conditions on the ground arguably ended up being a larger driver of project participation. The negative relationship between soil type and annual precipitation level may also indicate that farmers in difficult planting conditions were motivated to participate in the program to improve environmental conditions on their farm. It certainly seems to indicate that poor soil and precipitation were never prohibitive for Shelterbelt planting success. These results support the argument that the ultimate material impact of the project was driven not solely by climatic conditions, but by economic conditions, reinforcing that human systems of power continued to actively produce material conditions on the ground.

Conclusion

The Shelterbelt Project was largely derided by critics in both the popular press and the academy from the time of its initial conception. Decades after its completion, the legacy that followed the program in the national consciousness was that of "fiasco: a harebrained, hastily conceived make-work scheme that flopped, after wasting a potful of the taxpayer's money."[384] That reputation, however, did not align with the material results on the ground. As I have argued, this is because those criticisms were not made in good faith but were indicative of the competing spatial ontologies of climate that project critics employed in their own work. Huntington and Bowman's criticism of the project was not based in a critical assessment of the facts, but rather, was a dismissal of Zon's argument that climate was produced through a set of relationships which held the potential for change, a notion that ran counter to their agenda of mitigating problems through changes in land use or population resettlement. In the most obvious, concrete, and lasting refutation of the project's critics, the plantings survived. Over eighty years after the first plantings on H.E. Curtis' farm in Magnum, Oklahoma, the trees outlived their critics. As Roberts later recalled:

"…there is nothing to show that any of those who criticized the undertaking with such fervor ever visited the field operations either for the purpose of viewing the scientific and administrative methods employed, many of which were developed and put into practice during the course of the work, or to inspect the so vividly successful patterns of shelterbelts that within the life of the project, were protecting crops, conserving soil and moisture, and beautifying the countryside through the six shelterbelt states."[385]

Despite the criticisms the project endured and the funding that was cut, Forest Service employees and farmers on the ground worked cooperatively to plant over two hundred and seventeen million trees across six states, the result of Zon's attempts to translate daily

scientific research into the real, lived, and material betterment of people's lives on the Plains.

Though the origins of the Shelterbelt Project had roots in American nation building, the continual pressure that Zon and his friends and colleagues exerted within forestry attempted to center of the impact of economic and political policy decisions on environmental conditions, an argument for which they faced steep resistance. By bringing this spirit to the scientific design of the Shelterbelt Project's technical plans, Zon's ecological approach to forestry was also a disruption to the static idea of climate propagated by regional and climatic determinist geographers. Space is the continual product of human relations, and how we write, talk, and think about space matters, especially when it comes to which policy solutions are chosen for solving climatic problems. Though the difference between a static space and the conception of a continually produced space can appear almost semantic – a theoretical distinction –work, writings, thoughts, relationships, and scientific choices continually feed into the production of climate. I hope that this re-telling of the Shelterbelt Project serves as a reminder that working toward climate equity is not a zero-sum game, that material betterment of lives and land with an eye toward equity is possible and should be fought for, and that doing so will require push back against climatic and environmental conditions cast as static, endemic, or equated with the character, quality, or worthiness of an area's residents.

Figure 31: "Nation's First Shelterbelts in Magnum, Oklahoma (2016)"

Bibliography

Archive Abbreviations

AGS: Archives of the American Geographical Society at the University of Wisconsin-Madison

FHSLA: Forest History Society Library and Archives at North Carolina State University

Forestry Lectures of Carl Alwin Schenck, 1904-1909

LOC: Library of Congress

Gifford Pinchot Files, General Correspondence 1872-1946, Box 330

UWML: University of Wisconsin-Madison Library (Digital Collections)

Association of American Geographers, 1930-1935

Zon, Raphael, 1920-1934

NAKC: National Archives at Kansas City, MO

RG 114: Records of the Natural Resources Conservation Service, 1875-2002

General Records, 1934-1941

General Records, 1935-1938

NACP: National Archives at College Park, MD

Cartographic and Textual Records RG95

NSHS: Nebraska State Historical Society

RG2624 Stefan, Karl 1884-1951

RG3941 Paul Henley Roberts, 1891-1971

MSHS: Minnesota State Historical Society

P1237 Raphael Zon Papers

Published Works

Ahern, G., Marshall, R., Munns, E., Pinchot, G., Shephard, W., Sparhawk, W., & Zon, R. (1931). *A Letter to Foresters.* New York State Archives Digital Collections, Washington, DC. Retrieved from http://digitalcollections.archives.nysed.gov/index.php/Detail/Object/Show/object_id/17079

ArcMap Hot Spot Analysis (Getis-Ord Gi).* (2018, February 15). Retrieved from ESRI Spatial Statistics: http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-statistics-toolbox/hot-spot-analysis.htm

Atack, J. (2016). Historical Geographic Information Systems database of US Railroads, 1826-1911. Retrieved from https://my.vanderbilt.edu/jeremyatack/data-downloads/

Auerbach, L. E. (1965, June). Scientists in the new deal: A pre-war episode in the relations between science and government in the United States. *Minerva*, 457-482.

Aughey, S. (1880). *Sketches of the Physical Geography and Geology of Nebraska.* Omaha, Nebraska: Daily Republican Book and Job Office.

Aurousseau. (1975). Ellsworth Huntington: His Life and Thought. by Geoffrey J. Martin, Arnold J. Toynbee. *Annals of the Association of American Geographers, 65*(1), 73-76.

Bates, C. G. (1911). *Windbreaks: Their Influence and Value.* Washington, D.C.: U.S. Department of Agriculture, Forest Service.

Bates, C. G. (1921). First Results In the Streamflow Experiment, Wagon Wheel Cap, Colorado. *Journal of Forestry, 19*(4), 402-408.

Bates, C. G. (1934, December). The Plains Shelterbelt Project. *Journal of Forestry, 32*(9), 978-991.

Bergman, J. H. (2014). *Climates on the Move: Climatology and the Problem of Economic and Environmental Stability in the Career of C.W. Thornthwaite, 1933-1963.* Boston: Harvard University.

Bissett, J. (2002). *Agrarian Socialism in America: Marx, Jefferson, and Jesus in the Oklahoma Countryside, 1904–1920.* Norman: University of Oklahoma Press.

Bowman, I. (1935, January). Our Expanding and Contracting "Desert". *Geographical Review*, 43-61.

Bowman, I. (1935). The Land of Your Possession. *Science, 82*, 285-293.

Brinkley, D. (2011). *The Quiet World: Saving Alaska's Wilderness Kingdom, 1879-1960.* Harper.

Brock, E. K. (2015). *Money Trees: The Douglas Fir and American Forestry, 1900–1944.* Oregon State University Press.

Carhart, A. H. (1960, October). Shelterbelts: A "Failure" that Didn't Happen. *Harper's Magazine*.

Castree, N. (2004). Nature is dead! Long live nature! *Environment and Planning A, 36*(2), 191 – 194.

Catledge, T. (1935, March 17). M'CARL KEEPS RIGHT ON SAYING 'NO'; The Controller General Opposes Presidents and High Officials and Yet Holds Fast to His Unusual Job. *The New York Times*.

Chang, M. (2010, 07 22). *History of Forestry - Historical Context*. Retrieved from North Carolina State University Library Special Collecions: History of Forestry: http://www.lib.ncsu.edu/specialcollections/forestry/background.html

Chapman, H. (1934, December 01). Digest of Opinions Received on the Shelterbelt Project. *Journal of Forestry, 32*(9), 952-957.

Chapman, H. (1934). Editorial: The Shelterbelt Tree Planting Project. *Journal of Forestry, 32*(8), 801-803.

Chapman, H. (1934, December 01). Individual Letters Received on Shelterbelt Project. *Journal of Forestry*, 957-972.

Conrad, D. E., & Cravens, J. H. (1997). *The land we cared for--: a history of the Forest Service's Eastern Region.* Milwaukee: United States Forest Service, Eastern Region.

Cosgrove, D. E. (1984). *Social Formation and Symbolic Landscape.* Madison: University of Wisconsin Press.

Cowles, H. C. (1899, February 01). The Ecological Relations of the Vegetation on the Sand Dunes of Lake Michigan. Part I.-Geographical Relations of the Dune Floras. *International Journal of Plant Sciences, 27*(2).

Cronon, W. (1992). *Nature's Metropolis: Chicago and the Great West.* New York: W. W. Norton & Company.

Cronon, W. (1996). *Uncommon Ground: Rethinking the Human Place in Nature.* New York, New York, USA: W. W. Norton & Company.

Davis, R. C. (1989). *Rupert's Land: A Cultural Tapestry.* Calgary: Wilfrid Laurier University Press .

Davis, W. M. (1899, November). The Geographical Cycle. *The Geographical Journal, 14*(5), 481-504.

Davis, W. M. (1924). The Progress of Geography in the United States. *Annals of the Association of American Geographers*, 159-215.

Dodds, G. B. (1969). The Stream-Flow Controversy: A Conservation Turning Point. *The Journal of American History, 56*(1), 59-69.

Droze, W. H. (1977). *Trees, Prairies, and People: A History of Tree Planting in the Plains States.* Texas Woman's University.

ESRI. (2018, February 15). *Interpreting GWR results*. Retrieved from ESRI Resources: http://resources.esri.com/help/9.3/arcgisdesktop/com/gp_toolref/spatial_statistics_tools/interpreting_gwr_results.htm

ESRI. (2018). *Ordinary Least Squares (OLS)*. Retrieved November 2018, from http://pro.arcgis.com/en/pro-app/tool-reference/spatial-statistics/ordinary-least-squares.htm

Fedkiw, J. (2006, 08). Ideas Have Consequences. *Journal of Forestry, 104*(5).

Forest History Society. (2018, May). *Passing the Weeks Act*. Retrieved from Forest History Society: https://foresthistory.org/research-explore/us-forest-service-history/policy-and-law/the-weeks-act

Fry, A., & Fritz, E. (1972). *Emanuel Fritz, teacher, editor and forestry consultant : transcript, 1958-1967.* Berkeley: University of California. Retrieved from https://archive.org/details/emanuelteacher00fritrich

Godfrey, A. (2005). *The Ever-Changing View: A History of the National Forests in California, 1891-1987.* United States Government Printing Office.

Graves, H. S. (1934). A National Plan for American Forestry. *Geographical Review, 24*(1), 129-133.

Guyot, A. (1853). *The earth and man : lectures on comparative physical geography in its relation to the history of mankind.*

Hall, R. (1930, April). Observations on the "Letter". *Journal of Forestry*.

Hall, W. L. (1934, December). The Grand Shelterbelt Project. *Journal of Forestry*, 973-974.

Helms, J. D. (n.d.). *Lowdermilk, Walter Clay*. Retrieved July 2018, from Dictionary of North Carolina Biography: https://www.ncpedia.org/biography/lowdermilk-walter-clay

Henderson, G. L. (1998). *California and the Fictions of Capital.*

Hill, J. (2013). *The WPA -- Putting America to Work.* Detroit: Omnigraphics.

Hopkins, H. (1938). *Report on the Progress of the WPA Program.* Washington: Works Progress Administration.

Hopkins, J. (1999). The Road Not Taken: Harry Hopkins and New Deal Work Relief. *Presidential Studies Quarterly, 29*(2), 306-316.

Hudson, B. (1977, 09 01). The New Geography and the New Imperialism: 1870–1918. *Antipode*, 12-19.

Hudson, M. (2011). *Fire Management in the American West.* University Press of Colorado .

Hulme, M. (2008). Geographical work at the boundaries of climate change. *Transactions of the Institute of British Geographers, 33*(1), 5-11.

Huntington, E. (1915). *Civilization and Climate.* New Haven: Yale University Press.

Huntington, E. (1924). Geography and Natural Selection: A Preliminary Study of the Origin and Development of Racial Character. *Annals of the Association of American Geographers, 14*, 1-16.

Huntington, E. (1934, 11 01). Marginal Land and the Shelter Belt. *Journal of Forestry, 32*(8).

Hurt, R. D. (n.d.). *Forestry on the Great Plains, 1902-1942*. Retrieved January 2017, from http://www-personal.k-state.edu/~jsherow/hurt2.htm

Jefferson, M. (1928). The Civilizing Rails. *Economic Geography*, 217-231.

Jones, C. B. (1936, May 31). Tree-Belt, Great Vision of New Deal, Sacrificed. *The Evening Star*.

Jones, R. M. (1934, September 9). TREE BELT AROUSES LITTLE ENTHUSIASM. *The New York Times*, 68.

Kargon, R., & Hodes, E. (1985, September). Karl Compton, Isaiah Bowman, and the Politics of Science in the Great Depression. *Isis, 76*(3), 300-318.

Kellogg, R. S. (1934, September 16). Forest Planting Scheme Is Condemned As Expensive, Difficult and of No Use When Done. *The New York Times*, 71.

Kellogg, R. S. (1934, December 01). The Shelterbelt Scheme. *Journal of Forestry, 32*(9), 974-977.

Klingle, B. (2003). Spaces of Consumption in Environmental History. *History and Theory, 42*(4), 94-110. doi:10.1046/j.1468-2303.2003.00260.x

Lake States Experiment Station, U. S. (1935). *Possibilities of Shelterbelt Planting in the Plains Region.* Washington, DC: Government Printing Office.

Lambourne, M. J. (1947, May 26). That Shelter Belt Venture: It Worked and the Results on 33,000 Farms Have Vindicated A Debated Decision. *the Evening Star*.

Lewis, J. G. (2000, November). Raphael Zon and Forestry's First School of Hard Knocks. *Journal of Forestry*, 13-17.

Lewis, M. G. (1998). Rhetoric of the Western Interior: Modes of Environmental Description in American Promotional Literature of the Nineteenth Century. In D. Cosgrove, *The Iconography of Landscape: Essays on the Symbolic Representation, Design and Use of Past Environments* . Cambridge University Press.

Livingstone, D. N. (1992). *The Geographical Tradition.* Cambridge, Massachusetts: Blackwell.

Manson, S., Schroeder, J., Van Riper, D., & Ruggles, S. (2018). IPUMS National Historical Geographic Information System: Version 13.0 [Database]. Minneapolis: University of Minnesota, MN.

Massey, D. (2003). Some Times of Space. In O. Eliasson, *The Weather Project.* Retrieved from http://olafureliasson.net/archive/read/MDA111195/some-times-of-space-by-doreen-massey

Massey, D. (2013, 02 01). Doreen Massey on Space. Social Science Bites Podcast. Retrieved from http://www.socialsciencespace.com/2013/02/podcastdoreen-massey-on-space/

Mather, J. M., & Sanderson, M. (1996). *The Genius of C. Warren Thornthwaite, Climatologist-Geographer.* Norman: University of Oklahoma Press.

McGeary, M. N. (1960). *Gifford Pinchot, Forester-Politician.* Princeton, New Jersey: Princeton University Press.

Meyer, W. B. (2014). *Americans and Their Weather.* Oxford University Press.

Mill, R. H. (1905). The Present Problems of Geography. *The Geographical Journal, 25*(1), 1-17.

Miller, C. (1992). The Greening of Gifford Pinchot. *Environmental History Review, 16*(3), 1-20.

Miller, C. (1992). Wooden Politics: Bernhard Fernow and the Quest for a National Forest Policy, 1876-1898. In H. K. Steen, *The Origins of the National Forests* (pp. 287-301). Durham: Forest History Society.

Mitchell, D. (2012). *They Saved the Crops: Labor, Landscape, and the Struggle over Industrial Farming in Bracero-Era California.* Athens: University of Georgia Press.

National Oceanic and Atmospheric Administration. (1933). Annual Climatological Summary CSV. (N. C. Information, Compiler) Retrieved from https://www.ncdc.noaa.gov/cdo-web/

Pearce, F. (2015). *The New Wild: Why Invasive Species Will Be Nature's Salvation.* Beacon Press.

Peet, R. (1985, September). The Social Origins of Environmental Determinism. *Annals of the Association of American Geographers, 75*(3), 309-333.

Phillips, S. T. (2007). *This Land, This Nation: Conservation, Rural America, and the New Deal.* New York: Cambridge University Press.

Pinchot, G. (1998). *Breaking New Ground.* Island Press.

Pinchot, G. (2001). *The Conservation Diaries of Gifford Pinchot.* (H. Steen, Ed.) Forest History Society.

Powell, J. (1978). The Bowman, Huntington and Taylor correspondence, 1928. *Australian Geographer*, *14*(2), 123-125.

Press, A. (1941, March 20).

Rauchway, E. (2008). *The Great Depression and the New Deal: A Very Short Introduction.* Oxford: Oxford University Press.

Reed, F. W. (1930, April). Is Forestry A Religion? *Journal of Forestry*.

Richards, E. (1926). Raphael Zon--The Man. *Journal of Forestry,*, *24*(8), 850-857.

Roberts, P. (1968). The Prairie States Forestry Project (Unpublished Draft).

Roosevelt, F. D. (1972). *Franklin D. Roosevelt & Conservation, 1911-1945.* (E. B. Nixon, Ed.) Hyde Park, New York: Franklin D. Roosevelt Library.

Rutkow, E. (2013). *American Canopy: Trees, Forests, and the Making of a Nation.* New York: Scribner.

Sartz, R. S. (1977). Carlos G. Bates: Maverick Forest Service Scientist. *Journal of Forest History*, *21*(1), 31-39.

Sauer, C. O. (1934). *Preliminary Report to the Land-Use Committee on Land Resource and Land Use In Relation to Public Policy.* University of California. Washington, DC: Science Advisory Board.

Sauer, C. O. (1963). *Land and Life.* (J. Leighly, Ed.) Berkeley: University of California Press.

Schein, R. (1997). The Place of Landscape: A Conceptual Framework for Interpreting an American Scene. *Annals of the Association of American Geographers, 87*, 660-680.

Schmaltz, N. J. (1980, January 01). Raphael Zon: Forest Researcher. *Forest & Conservation History*, 24-39. doi:10.2307/4004435

Schmaltz, N. J. (1980, April 01). Raphael Zon: Forest Researcher—Part 2. *Forest & Conservation History*, 86-97.

Schuyler, M. W. (1978, April). The Plow that Broke the Plains. *Buffalo Tales: Buffalo County Historical Society, 1*(4). Retrieved from The Plow That Broke the Plains: http://www.bchs.us/BTales_197804.htm

Shapiro, A. (2014). A Grand Experiment: USDA Forest Service Experimental Forests and Ranges. In D. Hayes, *USDA Forest Service Experimental Forests and Ranges: Research for the Long Term* (pp. 3-23).

Silcox, F. (1935). Section 1: The Problem. In U. S. The Lakes States Experiment Station, *Possibilities of Shelterbelt Planting in the Plains Region.* Washington, District of Columbia: Government Printing Office.

Silcox, F. A. (1934, July 29). TO INSURE AGAINST DROUGHT, A VAST PLAN TAKES SHAPE; The Program for a Belt of Trees Reaching From Canada to Texas Envisages Modification of the Climate of the Great Plains. *The New York Times*.

Smith, H. N. (1947). Rain Follows the Plow: The Notion of Increased Rainfall for the Great Plains, 1844-1880. *Huntington Library Quarterly*, 169-193.

Smith, H. N. (2007). *Virgin Land: The American West as Symbol and Myth.* Cambridge: Harvard University Press.

Smith, K. L. (1986). *Sawmill: The Story of Cutting the Last Great Virgin Forest East of the Rockies.* University of Arkansas Press.

Smith, N. (1987). Academic War over the Field of Geography: The Elimination of Geography at Harvard, 1947-1951. *Annals of the Association of American Geographers, 77*(2), 155-172. Retrieved from http://www.jstor.org/stable/2562763

Smith, N. (2004). *American Empire: Roosevelt's Geographer and the Prelude to Globalization.* Berkeley: University of California Press.

Smith, N. (2008). *Uneven Development: Nature, Capital, and the Production of Space.* Athens, Georgia: University of Georgia Press.

Steen, H. K. (2013). *The U.S. Forest Service: A Centennial History.* Seattle: University of Washington Press.

Stowell Smith, C. (1930, April). De-Bunking Forestery. *Journal of Forestry*.

The New York Times. (1935, June 27). Says Climate Data May Save Arid Zone: Dr. Bowman Calls Neglected Weather Facts More Valuable Than Klondike's Gold. *The New York Times*, 22.

Thornthwaite, C. W. (1931). The Climates of North America: According to a New Classification. *Geographical Review, 21*(4), 633-655.

United Press. (1935, December 4). Part of Shelter-Belt Doomed, Says Board. *The Washington Post*, 11.

United States Department of Agriculture Natural Resource Conservation Service. (2016). *Soil Survey Geographic Database (SSURGO)*. (S. S. Staff, Editor) Retrieved from https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053627

Vanderbilt, T. (2016, May 11). Letter of Recommendation: U.S.G.S. Topographical Maps. *The New York Times*. Retrieved from https://www.nytimes.com/2016/05/15/magazine/letter-of-recommendation-usgs-topographical-maps.html

Veblen, T. T. (2017). Disturbance in Biogeography. In D. Richardson, N. Castree, M. Goodchild, A. Kobayashi, W. Liu, & R. Marston, *International Encyclopedia of Geography: People, the Earth, Environment and Technology.* Wiley.

Wallace, H. (1972). "Forest Planting Possibilities in the Prairie Region". In E. Nixon, *Franklin D. Roosevelt and Conservation, 1911-1945.* Hyde Park.

Well Known Lumber Secretaries Called to New Duties. (1915, January 1). *The Lumber Trade Journal*, 50.

Whittlesey, D. (1929). Sequent Occupance. *Annals of the Association of American Geographers, 19*(3), 162-165. doi:10.2307/2560607

Williams, M. (1983). “The apple of my eye”: Carl Sauer and historical geography. *Journal of Historical Geography, 9*, 1-28.

Williams, R. (2005). *Culture and Materialism: Selected Essays.* Verso.

Worster, D. (2004). *Dust Bowl: The Southern Plains in the 1930s.* New York: Oxford University Press.

Young, J. C. (2010). Warrior of Science: Raphael Zon and the Origins of Forest Experiment Stations. *Forest History Today*, 4-12.

Zimmerman, E. (1976). *A historical summary of state and private forestry in the U.S. Forest Service.* Washington: U.S. Dept. of Agriculture, Forest Service, State and Private Forestry.

Zon, R. (1909). *The future use of land in the United States.* U. S. Department of Agriculture. Washington, DC: Government Printing Office.

Zon, R. (1913). Darwinism in Forestry. *The American Naturalist*.

Zon, R. (1926). Who Will Lead Forest Research? *Journal of Forestry, 24*(5).

Zon, R. (1927). *Forest and Water in the Light of Scientific Investigation.* Senate Document No. 469, 62nd Congress, 2nd Session, Final Report of the National Waterways Commission, 1912. Washington, DC: United States Government Printing Office. Retrieved from https://babel.hathitrust.org/cgi/pt?id=uiug.30112069657762;view=1up;seq=1

Zon, R. (1935, 04 01). Shelterbelts - Futile Dream or Workable Plan? *Science*, 391-394.

Zon, R. (1941). Climate and the Nation's Forests. Yearbook of Agriculture, 1941. In *Climate and Man.* Washington, DC: 77th Congress,1st Session. House Document No. 27.

Notes

[1] Carhart, 1960

[2] Smith H. N., Virgin Land: The American West as Symbol and Myth, 2007

[3] Smith H. N., Virgin Land: The American West as Symbol and Myth, 2007

[4] Davis R. C., 1989, p. 256

[5] Davis R. C., 1989, p. 256

[6] Smith H. N., Virgin Land: The American West as Symbol and Myth, 2007

[7] Manson, Schroeder, Van Riper, & Ruggles, 2018

[8] Bissett, 2002

[9] Rutkow, 2013

[10] Smith H. N., 1947

[11] Rutkow, 2013

[12] Smith H. N., 1947

[13] Smith H. N., Rain Follows the Plow: The Notion of Increased Rainfall for the Great Plains, 1844-1880, 1947

[14] Rutkow, 2013

[15] Aughey, 1880, p. 155

[16] Smith H. N., Virgin Land: The American West as Symbol and Myth, 2007

[17] Lewis M. G., 1998, p. 183

[18] Lewis M. G., 1998, p. 181

[19] Lewis M. G., 1998, p. 184

[20] Lewis M. G., 1998

[21] Lewis M. G., 1998

[22] Atack, 2016

[23] Pinchot, Breaking New Ground, 1998

[24] Pinchot, Breaking New Ground, 1998

[25] Pinchot, Breaking New Ground, 1998

[26] Miller, The Greening of Gifford Pinchot, 1992, p. 5

[27] Pinchot, Breaking New Ground, 1998

[28] Pinchot, Breaking New Ground, 1998

[29] Miller, Wooden Politics: Bernhard Fernow and the Quest for a National Forest Policy, 1876-1898, 1992

[30] Miller, Wooden Politics: Bernhard Fernow and the Quest for a National Forest Policy, 1876-1898, 1992

[31] Pinchot, Breaking New Ground, 1998

[32] Pinchot, Breaking New Ground, 1998

[33] Pinchot, Breaking New Ground, 1998

[34] Pinchot, Breaking New Ground, 1998

[35] Chang, 2010

[36] Lewis J. G., 2000

[37] Lewis J. G., 2000

[38] (Miller, Wooden Politics: Bernhard Fernow and the Quest for a National Forest Policy, 1876-1898, 1992)

[39] Pinchot, Breaking New Ground, 1998

[40] Miller, Wooden Politics: Bernhard Fernow and the Quest for a National Forest Policy, 1876-1898, 1992

[41] Miller, Wooden Politics: Bernhard Fernow and the Quest for a National Forest Policy, 1876-1898, 1992

[42] Miller, The Greening of Gifford Pinchot, 1992, p. 9

[43] Hudson M., 2011, p. 65

[44] Pinchot, Breaking New Ground, 1998

[45] Pinchot, Breaking New Ground, 1998

[46] Pinchot, Breaking New Ground, 1998

[47] Schuyler, 1978

[48] Hill, 2013

[49] Hill, 2013

[50] Hill, 2013, p. 18

[51] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[52] Meyer, 2014

[53] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[54] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[55] Phillips, 2007, p. 59

[56] Bissett, 2002

[57] Bissett, 2002

[58] Manson, Schroeder, Van Riper, & Ruggles, 2018

[59] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[60] Brinkley, 2011

[61] Lambourne, 1947

[62] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[63] Roosevelt, 1972

[64] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[65] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[66] Roosevelt, 1972

[67] Wallace 1972

[68] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[69] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[70] F. Silcox 1935

[71] Roosevelt, 1972

[72] Manson, Schroeder, Van Riper, & Ruggles, 2018

[73] Hudson M. , 2011, p. 63

[74] Shapiro, 2014, p. 6

[75] Young, 2010, p. 6

[76] Brock, 2015, p. 56

[77] Brock, 2015, p. 41

[78] Schmaltz, Raphael Zon: Forest Researcher, 1980

[79] Brock, 2015, p. 42

[80] Brock, 2015, p. 59

[81] Schmaltz, Raphael Zon: Forest Researcher, 1980

[82] Schmaltz, Raphael Zon: Forest Researcher, 1980

[83] Davis W. M., 1899, p. 484

[84] Davis W. M., 1899, p. 497

[85] Veblen, 2017, p. 1555

[86] Cowles, 1899, p. 95

[87] Brock, 2015

[88] Brock, 2015

[89] Pearce, 2015

[90] Lewis J. G., 2000

[91] Schmaltz, Raphael Zon: Forest Researcher, 1980

[92] Richards, 1926

[93] Schmaltz, Raphael Zon: Forest Researcher, 1980

[94] Young, 2010, p. 6

[95] Young, 2010, p. 6

[96] Brock, 2015, p. 59

[97] Brock, 2015, p. 59

[98] Brock, 2015, p. 61

[99] Schmaltz, Raphael Zon: Forest Researcher, 1980

[100] Sartz, 1977

[101] Sartz, 1977

[102] Sartz, 1977

[103] Sartz, 1977

[104] Brock, 2015, p. 62

[105] Brock, 2015

[106] Brock, 2015

[107] Zon, Darwinism in Forestry, 1913

[108] Schmaltz, Raphael Zon: Forest Researcher—Part 2, 1980

[109] Schmaltz, Raphael Zon: Forest Researcher, 1980

[110] McGeary, 1960, p. 115

[111] McGeary, 1960, p. 116

[112] McGeary, 1960, p. 121

[113] McGeary, 1960, p. 128

[114] McGeary, 1960, p. 129

[115] McGeary, 1960, p. 146

[116] Forest History Society, 2018

[117] Forest History Society, 2018

[118] Zon, Forest and Water in the Light of Scientific Investigation, 1927

[119] (Bates, First Results In the Streamflow Experiment, Wagon Wheel Cap, Colorado, 1921)

[120] Forest History Society, 2018

[121] The Weeks Bill, 61st Congress, First Session. H.R. 11798.

[122] Pinchot, The Conservation Diaries of Gifford Pinchot, 2001, p. 92

[123] Dodds, 1969, p. 62

[124] Miller, The Greening of Gifford Pinchot, 1992, p. 11

[125] Hudson M., 2011, p. 77

[126] Hudson M., 2011, p. 76

[127] Brock, 2015, p. 88

[128] Fedkiw, 2006

[129] Zon, Who Will Lead Forest Research?, 1926

[130] Zon, Who Will Lead Forest Research?, 1926

[131] Brock, 2015, pp. 82-83

[132] Brinkley, 2011

[133] Brock, 2015, p. 83

[134] Brock, 2015, p. 83

[135] Brinkley, 2011

[136] Brock, 2015, p. 88

[137] Ahern, et al., 1931, p. 1

[138] Ahern, et al., 1931, p. 1

[139] Ahern, et al., 1931, p. 2

[140] Ahern, et al., 1931, p. 3

[141] Ahern, et al., 1931, p. 3

[142] Ahern, et al., 1931, p. 3

[143] Brinkley, 2011

[144] Raphael Zon to Ward Shepard, 27 February 1930. MNHS P1237 Box 6.

[145] Raphael Zon to W.H. Kenety, 4 March 1930. MNHS P1237 Box 6.

[146] Schmaltz, Raphael Zon: Forest Researcher—Part 2, 1980

[147] Schmaltz, Raphael Zon: Forest Researcher—Part 2, 1980

[148] Schmaltz, Raphael Zon: Forest Researcher, 1980

[149] Hall R., 1930, p. 460

[150] Hall R., 1930, p. 461

[151] Hall R., 1930, p. 459

[152] Reed, 1930

[153] Reed, 1930

[154] Hudson M., 2011

[155] Conrad & Cravens, 1997, p. 40

[156] Graves, 1934

[157] Graves, 1934

[158] Hudson M., 2011

[159] Richards, 1926

[160] Jones C. B., 1936

[161] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[162] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[163] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[164] Zon, Shelterbelts - Futile Dream or Workable Plan?, 1935

[165] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[166] Raphael Zon to Arthur Pack, 10 July 1934. MNHS P1237, Box 9.

[167] Raphael Zon to Arthur Pack, 10 July 1934. MNHS P1237, Box 9.

[168] E.N. Munns to Raphael Zon, 9 July 1934. MNHS P1237, Box 9.

[169] Silcox F. A., 1934

[170] Silcox F. A., 1934

[171] Silcox F. A., 1934

[172] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[173] Map published in The New York Times, 29 July 1934

[174] Fry & Fritz, 1972, p. 173

[175] Brock, 2015

[176] Zon to Ahern, 14 August 1934. MNHS P1237, Box 9.

[177] Zon to Ahern, 14 August 1934. MNHS P1237, Box 9.

[178] Zon to Ahern, 14 August 1934. MNHS P1237, Box 9.

[179] Raphael Zon to E.C.M. Richards, 6 August 1934. MNHS P1237, Box 9.

[180] Bob Marshall to H.H. Chapman, 18 August 1934. MHS P1237, Box 9.

[181] Huntington, Marginal Land and the Shelter Belt, 1934

[182] Huntington, Marginal Land and the Shelter Belt, 1934

[183] Huntington, Marginal Land and the Shelter Belt, 1934

[184] Huntington, Marginal Land and the Shelter Belt, 1934

[185] Hulme, 2008

[186] Smith N. , Uneven Development: Nature, Capital, and the Production of Space, 2008

[187] Livingstone, 1992

[188] Smith N., Uneven Development: Nature, Capital, and the Production of Space, 2008, p. 15

[189] Smith N., Uneven Development: Nature, Capital, and the Production of Space, 2008

[190] Castree, 2004

[191] Livingstone, 1992

[192] Peet, 1985

[193] (Smith N. , American Empire: Roosevelt's Geographer and the Prelude to Globalization, 2004)

[194] Livingstone, 1992

[195] Davis W. M., 1924, p. 152

[196] Davis W. M., 1924, p. 152

[197] Aurousseau, 1975

[198] Aurousseau, 1975

[199] Brock, 2015, p. 58

[200] Huntington, Civilization and Climate, 1915

[201] Huntington, Civilization and Climate, 1915

[202] Huntington, Civilization and Climate, 1915

[203] Huntington, Civilization and Climate, 1915

[204] Hulme, 2008

[205] Huntington, Civilization and Climate, 1915

[206] Huntington, Civilization and Climate, 1915

[207] Huntington, Civilization and Climate, 1915

[208] Huntington, Marginal Land and the Shelter Belt, 1934

[209] Huntington, Marginal Land and the Shelter Belt, 1934

[210] Aurousseau, 1975

[211] Smith N., American Empire: Roosevelt's Geographer and the Prelude to Globalization, 2004

[212] Jefferson, 1928

[213] Jefferson, 1928

[214] Smith N., American Empire: Roosevelt's Geographer and the Prelude to Globalization, 2004

[215] Smith N., American Empire: Roosevelt's Geographer and the Prelude to Globalization, 2004

[216] Bergman, 2014, pp. 39-40

[217] Williams M., 1983

[218] Williams M., 1983

[219] Sauer C. O., 1934, p. 175

[220] Sauer C. O., 1934, p. 175

[221] Massey, Some Times of Space, 2003

[222] Klingle, 2003

[223] Royal S. Kellogg in The New York Times, 16 September 1934

[224] Jones R. M., 1934

[225] Associated Press 10 April 1939

[226] Carhart, 1960

[227] Worster, 2004

[228] Carhart, 1960

[229] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[230] E.C.M. Richards to F.A. Silcox, 18 September 1934.

[231] George P. Ahern to Raphael Zon. 29 September 1934.

[232] Kellogg R. S., 1934

[233] Kellogg R. S., 1934

[234] Jones C. B., 1936

[235] Catledge, 1935

[236] Droze, 1977

[237] Droze, 1977

[238] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[239] Raphael Zon to Isaiah Bowman, October 16, 1934. AGS. Zon, Raphael, 1920-1934.

[240] Powell, 1978

[241] Isaiah Bowman to Raphael Zon, October 30, 1934. AGS. Raphael Zon, 1920-1934.

[242] Frank E. Williams to Isaiah Bowman, October 26, 1934. AGS. Association of American Geographers, 1930-1935.

[243] Isaiah Bowman to Frank E. Williams, October 30, 1934. AGS. Association of American Geographers, 1930-1935.

[244] Bergman, 2014, p. 103

[245] Bergman, 2014, p. 104

[246] Kargon & Hodes, 1985, p. 302

[247] Auerbach, 1965, p. 457

[248] Auerbach, 1965, p. 458

[249] Kargon & Hodes, 1985, p. 307

[250] Bergman, 2014

[251] Smith N., American Empire: Roosevelt's Geographer and the Prelude to Globalization, 2004

[252] Kargon & Hodes, 1985, p. 309

[253] Auerbach, 1965, p. 459

[254] Auerbach, 1965, p. 461

[255] Kargon & Hodes, 1985, p. 313

[256] Kargon & Hodes, 1985, p. 315

[257] Kargon & Hodes, 1985, p. 316

[258] Bergman, 2014, p. 27

[259] Bergman, 2014, p. 18

[260] AGS, National Research Council, Science Advisory Board, Chicago Conference on Land Use, correspondence, 1934. Bowman to Sauer, 27 April 1934.

[261] Bergman, 2014, p. 46

[262] Bergman, 2014, p. 26

[263] Sauer C. O., 1934, p. 174

[264] Sauer C. O., 1934, p. 179

[265] Sauer C. O., 1934, p. 192

[266] Sauer C. O., 1934, p. 193

[267] Bergman, 2014, p. 50

[268] Sauer C. O., 1934, p. 199

[269] Sauer C. O., 1934, p. 228

[270] Helms, n.d.

[271] AGS, Sauer Carl O 1917-1934. Sauer to Bowman 20 November 1934

[272] Mather & Sanderson, 1996, p. 37

[273] Mather & Sanderson, 1996, p. 24

[274] Mather & Sanderson, 1996, p. 25

[275] Mather & Sanderson, 1996, p. 28

[276] Mather & Sanderson, 1996, p. 32

[277] Mather & Sanderson, 1996, p. 38

[278] Bergman, 2014, p. 68

[279] Bergman, 2014, pp. 68-69

[280] AGS. Editors' Files, Gladys M. Wrigley (1920-1949), Bowman, Isaiah, 1947-1950. Bowman to Dr. G.W. Wrigley, 20 June 1947.

[281] Brock, 2015

[282] Raphael Zon to Bob Marshall. 16 October 1934. MNHS P1237, Box 9.

[283] Raphael Zon to E.C.M. Richards. 25 October 1934. MNHS P1237, Box 9.

[284] E.C.M. Richards to Raphael Zon. 29 October 1934. MNHS P1237, Box 9.

[285] Bob Marshall to Raphael Zon. 4 November 1934. MNHS P1237, Box 9.

[286] Chapman, Editorial: The Shelterbelt Tree Planting Project, 1934

[287] Chapman, Editorial: The Shelterbelt Tree Planting Project, 1934

[288] Chapman, Digest of Opinions Received on the Shelterbelt Project, 1934

[289] Chapman, Digest of Opinions Received on the Shelterbelt Project, 1934

[290] Chapman, Individual Letters Received on Shelterbelt Project 1934

[291] Chapman, Individual Letters Received on Shelterbelt Project 1934

[292] Chapman, Individual Letters Received on Shelterbelt Project 1934

[293] Chapman, Individual Letters Received on Shelterbelt Project 1934

[294] Chapman, Individual Letters Received on Shelterbelt Project 1934

[295] Chapman, Individual Letters Received on Shelterbelt Project 1934

[296] Chapman, Individual Letters Received on Shelterbelt Project 1934

[297] Chapman, Individual Letters Received on Shelterbelt Project 1934

[298] Kellogg R. S., 1934

[299] Kellogg R. S., 1934

[300] Schmaltz, Raphael Zon: Forest Researcher, 1980

[301] "Royal Shaw Kellogg Biography," p. 4. FHSLA Schenck, Series VI, Biographies.

[302] Smith K. L., 1986, p. 46

[303] Smith K. L., 1986, p. 116

[304] Hall W. L., 1934

[305] Hall W. L., 1934

[306] Hall W. L., 1934

[307] Chapman, Individual Letters Received on Shelterbelt Project, 1934

[308] Bates, The Plains Shelterbelt Project, 1934

[309] Bates, The Plains Shelterbelt Project, 1934

[310] Bates, The Plains Shelterbelt Project, 1934

[311] Bates, The Plains Shelterbelt Project, 1934

[312] Huntington, Marginal Land and the Shelter Belt, 1934

[313] Bates, The Plains Shelterbelt Project, 1934

[314] Bates, The Plains Shelterbelt Project, 1934

[315] Raphael Zon to Bob Marshall. 14 November 1934. MNHS P1237, Box 9.

[316] Raphael Zon to Bob Marshall. 14 November 1934. MNHS P1237, Box 9.

[317] H.H. Chapman to Members of the Council. 20 December 1934. MNHS P1237, Box

[318] Fry & Fritz, 1972, p. 176

[319] Raphael Zon to F.A. Silcox, 27 September 1934. MNHS P1237, Box 9.

[320] Fry & Fritz, 1972, p. 176

[321] Fry & Fritz, 1972, p. 178

[322] Fry & Fritz, 1972, p. 181

[323] Fry & Fritz, 1972, p. 181

[324] Bowman, Our Expanding and Contracting "Desert", 1935, p. 43

[325] The New York Times, 1935

[326] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[327] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[328] Zon, Shelterbelts - Futile Dream or Workable Plan?, 1935

[329] Zon, Shelterbelts - Futile Dream or Workable Plan?, 1935

[330] Hill, 2013

[331] Hill, 2013

[332] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[333] Droze, 1977

[334] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[335] The New York Times, 1935

[336] The New York Times, 1935

[337] Bowman, The Land of Your Possession, 1935

[338] Bowman, The Land of Your Possession, 1935

[339] Bowman, The Land of Your Possession, 1935

[340] Bowman, The Land of Your Possession, 1935

[341] United Press, 1935

[342] Droze, 1977

[343] Droze, 1977

[344] 80 Congressional Record (1936), pg. 1716 (February 24)

[345] 80 Congressional Record (1936), pg. 1716 (February 24)

[346] Droze, 1977

[347] Droze, 1977

[348] Zimmerman, 1976

[349] Droze, 1977

[350] Droze, 1977

[351] Zimmerman, 1976

[352] Droze, 1977

[353] Droze, 1977

[354] Droze, 1977

[355] Zimmerman, 1976

[356] Hurt, n.d.

[357] Hopkins H. , 1938

[358] Droze, 1977

[359] Droze, 1977

[360] Droze, 1977

[361] Press, 1941

[362] Stefan in Congressional Record 1941. NAKC.

[363] Karl Stefan Collection, Series 1, Folder 53

[364] Paul Roberts to Karl Stefan, December 1941. NSHS Karl Stefan Collection, Series 1, Folder 53

[365] Karl Stefan to Paul Roberts, December 1941. NSHS Karl Stefan Collection, Series 1, Folder 53

[366] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.

[368] Jones C. B., 1936

[369] Associated Press. "U.S. Tree Planting Hailed By Farmers Once Skeptical." *The Evening Star*. April 10, 1939.

[370] NAKC, RG 114

[371] NACP RG 95. Entry 94, A-65; Area of Shelterbelt Planting to Date January 1941

[372] Vanderbilt, 2016

[373] Bates, The Plains Shelterbelt Project, 1934

[374] ArcMap Hot Spot Analysis (Getis-Ord Gi*), 2018

[375] Manson, Schroeder, Van Riper, & Ruggles, 2018

[376] Manson, Schroeder, Van Riper, & Ruggles, 2018

[377] National Oceanic and Atmospheric Administration 1933

[378] USDA Natural Resource Conservation Service 2016

[379] ESRI, Ordinary Least Squares (OLS) 2018

[380] Zon, Shelterbelts - Futile Dream or Workable Plan?, 1935

[381] ESRI, 2018

[382] ESRI, 2018

[383] ESRI, 2018

[384] Carhart, 1960

[385] Roberts, 1968. NSHS, RG 3941, Series 3, Folder 1.