

THE SHIFTING NATURE OF FOOD AND WATER ON THE HOPI INDIAN
RESERVATION

by

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TABLE OF CONTENTS

ABSTRACT.....	6
INTRODUCTION.....	7
CHAPTER ONE: LABOR, AGRICULTURE, AND ECONOMY.....	20
CHAPTER TWO: FOOD, HEALTH, AND AGROBIODIVERSITY.....	75
CHAPTER THREE: WATER.....	118
CHAPTER FOUR: LOCAL KNOWLEDGE AND ECOLOGICAL CHANGE.....	158
CONCLUSION.....	198
BIBLIOGRAPHY.....	202

ABSTRACT

On the southern escarpment of Black Mesa lie the longest continually inhabited settlements in North America. In a land where water is scarce and fierce winds move shifting dunes of sand, the Hopi people continue to dry farm fields of blue corn, irrigate terrace gardens, and tend livestock in one of the world's most biologically diverse food systems. Rooted in an intimate knowledge of local resources and ecology, Hopis produced the majority of food consumed in their communities well into the 1930s. Over the course of the twentieth century a cataclysm of social, economic, and environmental forces reshaped Hopi food and water systems, shifting the use and management of Hopi resources including labor, crops, livestock, and water. As Hopi relationships with these resources changed, so too did the production and consumption of Hopi foods. Farming, ranching, and gardening declined, as did agrobiodiversity. Food from the grocery store replaced food from the fields, contributing to rates of diabetes and obesity significantly higher than the national average. At the same time domestic and industrial development of Hopi ground and surface water transformed Hopi water systems. Today Hopi agriculturalists report declines in the water resources upon which agricultural success depends. These declines are limiting the decision and ability of Hopis to continue traditional agricultural practices. The persistent and long-term ecological observations of farmers, gardeners, and ranchers who continue to interact with these specific resources and the local environment through their agricultural practices are valuable in understanding ecological change over time, including how natural resource development and climate change are affecting traditional subsistence practices.

INTRODUCTION

On the southern escarpment of Black Mesa lie the longest continually inhabited settlements in North America. In a land where water is scarce and fierce winds move shifting dunes of sand, the Hopi people continue to dry farm fields of blue corn, irrigate terrace gardens, and tend livestock in one of the world's most biologically diverse food systems. Rooted in an intimate knowledge of local resources and ecology, Hopis produced the majority of food consumed in their communities well into the 1930s.

Over the course of the twentieth century a cataclysm of social, economic, and environmental forces reshaped Hopi food and water systems, shifting the use and management of Hopi resources including labor, biological resources including crops and livestock, and water. As Hopi relationships with these resources changed, so too did the production and consumption of Hopi foods. Farming, ranching, and gardening declined alongside agrobiodiversity and water resources. Food from the grocery store replaced food from the fields, contributing to rates of diabetes and obesity significantly higher than the national average.

By the beginning of the twenty-first century, food and water systems on the Hopi Indian Reservation that lies in what is now northern Arizona were transformed. Today the majority of farmers produce crops to fulfill cultural and social obligations and Hopi livestock are shipped to faraway markets, rather than being consumed at home. Both ranchers and farmers face increasing environmental pressures as weather has become unpredictable and water increasingly scarce. Interactions with distinct resources over time make these Hopis astute observers of ecological change. Both long-term and short-term observations of changes in plants, animals,

water, and climate constitute a resource that is critical to understanding both environmental history and how climate change is affecting Hopi agriculture.

Hopi agriculture is an institution that has been culturally and biologically evolving on Black Mesa for over one thousand years. Farming – and later livestock – has been a cultural lifeway of the Hopi people since their emergence into the Fourth World. Corn is the “central bond,” and is rooted in physical and spiritual life on the Hopi mesas. It is at once “sustenance, ceremonial object, prayer offering, symbol, and sentient being unto itself.”¹ Farming is an ever-evolving Hopi tradition that demonstrates a collective commitment to spiritual and ceremonial lifeways rooted in dry farmed fields of corn, as Leigh Kuwanwisiwma, director of the Hopi Cultural Preservation Office, explained.

You gotta be out there farming because the corn, the seed came from our spirit person. We came to this Fourth Way of life in search of peace and quiet and a new way. When we came here we met the spirit person that we call *Máasaw* and we acknowledged that this spirit person had dominion over this new way of life. So we respected that. We asked the person to be here with him, and stay with him. This spirit, *Máasaw*, looked us straight in the heart and said, ‘It’s up to you. I see you right into your heart and I know your history and your past - everything that you have brought here with you. Even though you say that you want to experience something new, a new way of life, I see deep inside that you still carry ambition. So I’m saying it’s up to you, because all I have to offer you is my planting stick, a pouch of seeds, and a gourd of water. Cause I can’t match your ambition. You’re saying that you want to be here with me; well it’s up to you. That’s all I have to offer you. So, you want to be here with me, then it’s up to you to accept my way of life.’ So the Hopi clans said, ‘We’ll submit to your way of life.’ That’s where again all these values come in, including humility. That’s who we are. So at that time, they say that since you have submitted to my way of life, then here is my life. So he offered the short blue ear of corn to the clans. It is the

¹ Dennis Wall and Virgil Masayesva, “People of the Corn: Teachings in Hopi Traditional Agriculture, Spirituality, and Sustainability,” *American Indian Quarterly* 28, no. 3/4 (July 2004): 436.

shortest ear of corn, and that represents humility. Because if you look at all the other things that are available you can get a long yellow ear of corn, you can get a long ear of white corn, but my life is the short blue ear of corn. And *sakwa* in Hopi represents blue-green, and blue-green represents corn and all the plant life and the water, and that's what the short blue ear of corn represents. So that's where we were offered that and we said, 'Kwak'whay. Thank you.' So we submitted to that way of life.²

The Hopi way of life over the next millennium revolved around the planting stick, pouch of seeds, and gourd of water *Máasaw* presented the people when they settled on Black Mesa. Farming in this hostile desert environment requires a deep understanding of ecology and the successful management of resources including labor, agrobiodiversity, and water. The determining factors of successful agriculture on the Hopi mesas include temperature, soil type, and precipitation.³ Labeled a “hedge-your-bets” strategy by some, Hopi agricultural practices are shaped by the extreme climate of northeastern Arizona's Colorado Plateau.⁴ Summers are hot, winters quite cold, and the amount and type of precipitation that falls on Hopi lands is exceptionally variable, with only around eight and a half inches per year. The climate is seasonably variable with wet seasons in the winter and summer punctuated by dry seasons in the autumn and spring. Winter storm patterns bring moisture to Hopi soils during the wet season of December through March, and precipitation increases dramatically with the arrival of summer monsoon rains in July which tend to stay through the end of the summer wet season in

² Leigh Kuwanwisiwma, interview by Tai Johnson, June 29, 2007, Kykotsmovi, Arizona, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

³ Maitland Bradfield, *The Changing Pattern of Hopi Agriculture*. (London: Royal Anthropological Institute, 1971), 1-6.

⁴ Scott Rushforth and Steadman Upham, *A Hopi Social History: Anthropological Perspectives on Sociocultural Persistence and Change* (Austin: University of Texas Press, 1992), 34.

September. The seasonality of precipitation on Hopi lands can drive drought cycles in both the long and short term.⁵

The moisture received during the winter wet season is critical to the survival of dry farmed corn planted in the spring, which often does not feel its first drop of rain until the onset of monsoon season. These dry farmed fields are but one place Hopis grow corn, although in the twenty-first century they are the most common. Other categories of Hopi field include fields watered by surface runoff (floodwater farming), those watered by underground seepage (seepage fields), and irrigated gardens and fields. Fields are positioned in relation to concentrations of surface runoff and/or the flow of groundwater, illustrating the relationship between pragmatic indigenous knowledge of water supplies and the diversification of Hopi agricultural practices.⁶

Hopi farmers raise fields of crops adapted to specific environmental conditions such as soil, climate and water resources. Such crops develop genetic adaptations to environmental stressors, particularly over long periods of time. On the Hopi mesas a harsh desert environment along with the tedious selection of seeds by Hopi women helped to build a diversified crop repertoire.⁷ Hopi crops adapted to a land with little water and extreme weather, developing morphological adaptations. For example, Hopi corn seedlings have a rapid elongation between the root and the first leaf of foliage. This permits the corn to emerge from the over twelve inches

⁵ Michael A. Crimmins et al., “Hopi Climate: An Overview to Support Drought Monitoring and Management” (Tucson: University of Arizona, 2015), 1–2.

⁶ John Tilton Hack, *The Changing Physical Environment of the Hopi Indians of Arizona*, Reports of the Awatovi Expedition, Peabody Museum, Harvard University. Report No. 1 (Cambridge, Mass: The Museum, 1942), 36.

⁷ Women play critical roles in the conservation of agrobiodiversity worldwide. See Virginia D. Nazarea, *Heirloom Seeds and Their Keepers: Marginality and Memory in the Conservation of Biological Diversity* (Tucson: University of Arizona Press, 2005); Kimberlee Chambers, “From the Kitchen and the Field: Gender and Maize Diversity in the Bajío Region of Mexico,” *Singapore Journal of Tropical Geography* 28, no. 1 (March 2007): 39–56.

of soil in which it is planted. Corn is planted this deep so that plants can access the moisture that resides deep in the soil as a result of the winter wet season.⁸ This adaptation also protects against the late frosts that occur on Black Mesa.⁹

Dry farmed Hopi crops are complemented with those grown in irrigated terrace gardens, a practice that still exists in Hopi villages today. Historically these plant resources formed the core of the Hopi diet and were supplemented with non-domesticated plants and livestock including sheep and, later, cattle. Like cultivating crops, tending livestock on the Hopi mesas requires intimate knowledge of the local environment and remains an important part of Hopi agriculture today. Combined with the gathering of non-domesticated plants for use in traditional foods, these biological resources are important components of agrobiodiversity on the Hopi Indian Reservation.¹⁰

This dissertation traces the shifting nature of Hopi food and water since the 1930s. It is the result of a multi-year collaboration with the Hopi Cultural Preservation Office, a branch of Tribal government founded in the 1980s. The Hopi Cultural Preservation Office is, in the words of anthropologist Peter Whitely, “the key intercessor in academic research, and the main

⁸ Gary Paul Nabhan, *Enduring Seeds: Native American Agriculture and Wild Plant Conservation*, (Tucson: University of Arizona Press, 2002), 71–2.

⁹ Hack, *The Changing Physical Environment of the Hopi Indians of Arizona*, 1942, 20.

¹⁰ The Food and Agriculture Organization of the United Nations defines agrobiodiversity as “the result of natural selection processes and the careful selection and inventive developments of farmers, herders, and fishers over millennia.” Agrobiodiversity, which is also referred to as agricultural biodiversity, includes harvested crop varieties, livestock breeds, fish species and animals hunted for food, non-harvested species that support food provision like pollinators and soil micro-biota, and species in the larger ecosystem that support food production but are not harvested. See Food and Agriculture Organization of the United Nations, “What Is Agrobiodiversity?,” 2004, <http://www.fao.org/docrep/007/y5609e/y5609e01.htm>.

guardian of intellectual sovereignty against raiders of Hopi symbolic capital.”¹¹ Those interested in conducting research that involves Hopi intellectual property must obtain a permit from the Hopi Cultural Preservation Office after submitting a proposal that adheres to the Tribe’s protocol for research, publication, and recordings central to which is the demonstration of the researcher’s intent and the benefit to the Hopi Tribe. Reciprocity is key, and the few who are granted permits must adhere to guidelines set out by the Hopi Cultural Preservation Office.¹²

After submitting a research proposal and presenting it to staff, the Hopi Cultural Preservation Office granted me a permit to conduct the interviews with Hopi farmers, ranchers, gardeners, and natural resource managers that form a central body of evidence in this dissertation. The University of Arizona Institutional Review Board and the U.S. Environmental Protection Agency Human Subjects Research Review then approved the human subjects research portion of the dissertation project, permitting me to conduct the interviews. I then worked with Hopi Cultural Preservation Office staff to develop interview questions and identify potential interviewees. Some days this meant introductions to other employees of the Hopi Tribe in the Tribal offices in Kykotsmovi. Others days included driving my old Honda Civic around the reservation with Tribal Archivist Stewart Koyiyumptewa riding shotgun as we visited the home and offices of men and women who might be interested in participating in the project. Those who chose to sit down with me for interviews often had suggestions for other men and women I should meet. All in all, I conducted interviews with twenty-three Hopi men and women. Many of the interviews were conducted in the offices of the Hopi Tribe in Kykotsmovi, Arizona, while

¹¹ Peter M Whiteley, *Rethinking Hopi Ethnography* (Washington, DC: Smithsonian Institution Press, 1998), 3.

¹² The Hopi Cultural Preservation Office’s research protocols and policy are available online at “HCPO Policy & Research,” accessed March 4, 2016, <http://www8.nau.edu/hcpo-p/research.html>.

others took place in the homes of individuals. Each interview was recorded using a digital recorder after participants signed informed consent paperwork from both the Hopi Tribe and the University of Arizona agreeing to their participation in the project. Upon completing the interview phase of my fieldwork, I transcribed the nearly thirty hours of interviews and then analyzed them using Atlas.ti qualitative data analysis and research software. I chose not to include the names of my interviewees in the manuscript to ensure the confidentiality and privacy of the men and women who chose to share their stories with me.

After analyzing the interviews, I then integrated this qualitative data with research conducted in the physical collections of multiple institutions including the National Archives and Records Administration, the Lyndon Baines Johnson Library and Museum, Museum of Northern Arizona, University of Arizona Special Collections, Native Seeds/Search, Cline Library Special Collections and Archives at Northern Arizona University, as well as digital resources including historic and contemporary scientific publications. Locating Hopi voices in the archive was not always an easy task, as the overwhelming majority of sources I was able to locate were written by non-Hopis. Federal records were particularly troublesome in this regard as in many instances Hopi records were interspersed with those of their Navajo neighbors, the result of a complicated history.¹³ In other cases, the records were either simply not there, had been relocated, or were not accessible to me as a researcher. Similarly, the lack of peer-reviewed scientific publications on Hopi natural resources and ecology limited the integration such studies into the oral narratives

¹³ The history and politics of relations between the Hopi Tribe and Navajo Nation are complex and outside this study's scope of inquiry. For more on this history in the context of the Hopi Navajo land dispute, see Emily Benedek, *The Wind Won't Know Me: A History of the Navajo-Hopi Land Dispute* (New York: Knopf : Distributed by Random House, 1992); David M Brugge, *The Navajo-Hopi Land Dispute: An American Tragedy* (Albuquerque: University of New Mexico Press, 1999).

shared with me by Hopi farmers, gardeners, and ranchers. These lacunae shaped my research process, analysis, and conclusions.

This dissertation is disciplinarily rooted in the broader literatures of environmental history, food history, and American Indian history. Over the past decade scholars of American Indian history have explored themes of economic development, wage labor, and native agency in their studies of shifting indigenous economies.¹⁴ Rather than seeing American Indians as casualties of capitalism, these historians and anthropologists illustrate the active roles individuals, communities, and tribes played and how traditions like Hopi farming have adapted to fit ever-evolving lifeways. As historian Colleen O’Neill argues, “the motor of change may be the encroaching capitalist system, but the road that it travels may indeed be shaped by the cultural, social and economic systems that lay in its path.”¹⁵ This dissertation contributes to these larger historiographical debates by demonstrating that in the Hopi case, the encroachment of capitalism was a process during which Hopis played important roles collectively and as individuals. Hopi actions and decisions shaped the ways in which economic and ecological change played out on a local level, often complicating the goals of policymakers.

¹⁴ Eric V. Meeks, “The Tohono O’odham, Wage Labor, and Resistant Adaptation, 1900-1930,” *The Western Historical Quarterly* 34, no. 4 (December 2003): 468–89; Garth M. Massey, “Making Sense of Work on the Wind River Indian Reservation,” *American Indian Quarterly* 28, no. 3/4 (July 2004): 786–816; Alice Littlefield and Martha C. Knack, eds. *Native Americans and Wage Labor: Ethnohistorical Perspectives* (Norman: University of Oklahoma Press, 1996); Brian C. Hosmer, *American Indians in the Marketplace: Persistence and Innovation among the Menominees and Metlakatans, 1870-1920* (Lawrence: University Press of Kansas, 1999); Brenda J. Child, *My Grandfather’s Knocking Sticks: Ojibwe Family Life and Labor on the Reservation* (St. Paul: Minnesota Historical Society Press, 2014); Caroline F. Butler and Charles R. Menzies, “Working in the Woods: Tsimshian Resource Workers and the Forest Industry of British Columbia,” *The American Indian Quarterly* 25, no. 3 (2001): 409–30.

¹⁵ Colleen O’Neill, *Working the Navajo Way: Labor and Culture in the Twentieth Century* (University Press of Kansas Press, 2005).

Histories of American Indian economic development in the twentieth century intertwine with those of shifting resources – both cultural and natural.¹⁶ A handful of environmental historians have addressed how these interrelated changes affected American Indian subsistence in the twentieth century, but the topic remains largely unexplored.¹⁷ This project contributes to broader conversations among historians and Hopis alike, tracing the evolution of economy and ecology over pivotal decades in the twentieth century within the context of Hopi agricultural practices. It strays from a simple narrative of declension, instead demonstrating the resilience of Hopi agricultural institutions in the face of increasing social, economic, and environmental challenges.

The research of historians whose work lies at the intersection of environmental history and agricultural history, more broadly, informs this study in its approach to understanding historical trends in agricultural technology, the mechanization and industrialization of American agriculture in the twentieth century, the connections between sites of production and

¹⁶ Donald Lee Fixico, *The Invasion of Indian Country in the Twentieth Century: American Capitalism and Tribal Natural Resources* (Boulder: University Press of Colorado, 2012); David H. DeJong, *Stealing the Gila: The Pima Agricultural Economy and Water Deprivation, 1848-1921* (Tucson: University of Arizona Press, 2009); Paul C. Rosier, “Searching for Salvation and Sovereignty: Blackfeet Oil Leasing and the Reconstruction of the Tribe,” in *Native Pathways: American Indian Culture and Economic Development in the Twentieth Century*, ed. Brian C. Hosmer, Colleen O’Neill, and Donald L. Fixico (Boulder: University Press of Colorado, 2004), 27–51; Benedict J. Colombi, “Dammed in Region Six: The Nez Perce Tribe, Agricultural Development, and the Inequality of Scale,” *American Indian Quarterly* 29, no. 3/4 (July 2005): 560–89; Michelle Steen-Adams, Nancy Langston, and David Mladenoff, “Logging the Great Lakes Indian Reservations: The Case of the Bad River Band of Ojibwe,” *American Indian Culture and Research Journal* 34, no. 1 (January 2010): 41–66.

¹⁷ Richard White, *The Roots of Dependency: Subsistence, Environment, and Social Change among the Choctaws, Pawnees, and Navajos* (Lincoln: University of Nebraska Press, 1988); David Rich Lewis, *Neither Wolf Nor Dog: American Indians, Environment, and Agrarian Change* (New York: Oxford University Press, 1997); Marsha Weisiger, *Dreaming of Sheep in Navajo Country* (Seattle: University of Washington Press, 2009).

consumption, and the evolution of agricultural landscapes over time.¹⁸ Many of these environmental histories of food systems focus on the production of commodities for a capitalist marketplace. In doing so, these scholars highlight important linkages between economic structures, ecology, ideology, and human interactions with the natural world.¹⁹ Using the production of food and timber as a lens to examine economic development and environmental change, William Cronon asserts that the “commodities that feed, clothe, and shelter us are among our most basic connections to the natural world.”²⁰ The production of the resources upon which human life depends creates hybrid landscapes that are as Mark Fiege suggests, “a compromise between human design and natural processes.”²¹ The examination of these landscapes reveals reciprocity between nature and culture, practice and ideology, and is critical to understanding the intimate ties that bind humans to local and global ecologies. These ties and the agricultural

¹⁸ William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1991); Sara Gregg, “Uncovering the Subsistence Economy in the Twentieth-Century South: Blue Ridge Mountain Farms,” *Agricultural History* 78, no. 4 (October 2004): 417–37; Deborah Kay Fitzgerald, *Every Farm a Factory: The Industrial Ideal in American Agriculture* (New Haven: Yale University Press, 2003); Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York: Oxford University Press, 1979); Geoff Cunfer, *On the Great Plains: Agriculture and Environment* (College Station: Texas A&M University Press, 2005); Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 1999).

¹⁹ John Soluri, “Accounting for Taste: Export Bananas, Mass Markets, and Panama Disease,” *Environmental History* 7, no. 3 (2002): 386–410; Mark Kurlansky, *Cod: A Biography of the Fish That Changed the World* (New York: Walker and Co., 1997); Worster, *Dust Bowl*; Mark Kurlansky, *Salt: A World History* (New York: Walker and Co., 2002); William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1992); Dan Koeppel, *Banana: the Fate of the Fruit That Changed the World* (New York: Hudson Street Press, 2008); Douglas Sackman, *Orange Empire: California and the Fruits of Eden* (Berkeley and Los Angeles: University of California Press, 2005); Fitzgerald, *Every Farm a Factory*; Pete Daniel, *Breaking the Land: The Transformation of Cotton, Tobacco, and Rice Cultures since 1880* (Urbana: University of Illinois Press, 1985).

²⁰ Cronon, *Nature's Metropolis*, xvii.

²¹ Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 1999), 205.

landscapes that foster them are often shaped by the politics of water in arid regions like the Southwest.²² Such connections facilitate continual renegotiations with resources including food and water over time, and this project contributes to a more inclusive historical analysis of these issues in the American West.

Scholarly interest in the history of food has grown over the past two decades. This in many ways reflects a growing popular interest in the dynamics of food production and consumption, concerns regarding the environmental and public health implications of an increasingly globalized food system, and locating the roots and historical contours of the modern American diet. Recent scholarship has explored food history through a variety of lenses including race, gender, class, culture, and politics, producing an evolving historiography of American foodways in the twentieth century and beyond.²³ American Indians are rarely included in these discussions, and this project's examination of food and public health from a Hopi perspective fills a gap in this growing body of literature.

²² Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (Oxford University Press, 1992); Richard White, *The Organic Machine* (New York: Hill and Wang, 1995); Charles F. Wilkinson, *Fire on the Plateau: Conflict And Endurance In The American Southwest* (Washington, D.C.: Island Press, 1999); Marc Reisner, *Cadillac Desert: The American West and Its Disappearing Water* (New York: Viking, 1986).

²³ Warren Belasco and Philip Scranton, eds., *Food Nations: Selling Taste in Consumer Societies* (New York: Routledge, 2001); Charlotte Biltekoff, *Eating Right in America: The Cultural Politics of Food and Health* (Durham: Duke University Press Books, 2013); Michael Carolan, *Embodied Food Politics* (Ashgate, 2012); Tracey Deutsch, *Building a Housewife's Paradise: Gender, Politics, and American Grocery Stores in the Twentieth Century*, (Chapel Hill: The University of North Carolina Press, 2012); Psyche A. Williams-Forson, *Building Houses out of Chicken Legs: Black Women, Food, and Power* (Chapel Hill: The University of North Carolina Press, 2006); Shane Hamilton, "Cold Capitalism: The Political Ecology of Frozen Concentrated Orange Juice," *Agricultural History* 77, no. 4 (October 2003): 557–81; Susan Levine, *School Lunch Politics: The Surprising History of America's Favorite Welfare Program* (Princeton: Princeton University Press, 2010); Helen Zoe Veit, *Modern Food, Moral Food: Self-Control, Science, and the Rise of Modern American Eating in the Early Twentieth Century* (Chapel Hill: The University of North Carolina Press, 2013).

Organized into thematic chapters, this dissertation explores the multiple factors that contributed to environmental and socioeconomic change on the Hopi Indian Reservation and in doing so demonstrates the multicausal nature of these historic transformations. The first chapter traces the intertwined transformations of Hopi labor, agriculture, and economy since 1930, considering the roles played by wage labor, federal policy, and technology in both agricultural decline and resiliency. This assessment sets the stage for the second chapter, which examines changes in agrobiodiversity, consumption patterns, and public health, linking the move away from a traditional Hopi diet to broader changes in Hopi health including increasing rates of obesity and diabetes. Chapter three shifts the focus to Hopi water resources, following the multiple contours of both domestic and industrial development since the 1930s. The final chapter explores Hopi observations of water resources and climate over time, utilizing local ecological knowledge as a tool for assessing environmental change over time.

The exploration of Hopi water and food systems from 1930 through the present provides an opportunity to better understand how far-reaching ecological, social, and economic changes affect local people and the places they call home. These changes signify a larger shift in the material conditions upon which these men and women built their lives. They are not unique to the Hopi Indian Reservation but are instead reflective of the experiences of rural peoples across the globe. A land where ecology and economy operated on a local scale was rapidly transformed to a place whose human and natural resources were increasingly extracted to fulfill the larger needs of a rapidly developing global economy. Extraction, however, is only one lens through which to view changes in both human and non-human resources on the Hopi Indian Reservation during the mid to late twentieth century. Hopi men and women - as wage laborers, and tribal council officials, and as farmers, ranchers, and gardeners – were active historical agents in these

transitions. Individuals sought wage labor jobs. Councilmen approved the development of natural resources including water and coal. Farmers bought tractors to adapt to decreased communal labor pools and increased time spent at a second job. As we shall see, what may on the surface appear as a simple story of agricultural declension and capitalist incorporation is instead woven together in a tapestry of historical agency, chance, and choice.

CHAPTER ONE LABOR, AGRICULTURE, AND ECONOMY

In the spring of 1931 a subcommittee of the United States Senate Committee on Indian Affairs visited the Hopi Indian reservation, holding hearings in Keams Canyon, Oraibi, Hotevilla, and Toreva. Part of a series of hearings the subcommittee held throughout Indian Country that spring, the Hopi hearings – like their predecessors – were part of a congressional investigation into the conditions of Indians throughout the United States authorized by Senate Resolutions 79 and 308 of the 70th Congress and Senate Resolutions 263 and 416 of the 71st Congress.²⁴ On May 18 subcommittee Chairman Senator Lynn J. Frazier of North Dakota arrived on the Hopi Mesas along with Senator Henry F. Ashurst of Arizona, Assistant Commissioner of Indian Affairs J. Henry Scattergood, and several staff members. The world into which they entered was one in which the majority of Hopis – who then numbered around 2,500 - were still engaged in the agricultural practices that had supported their people for generations.²⁵

As the subcommittee slowly made its way from village to village on rutted, storm-damaged roads, they observed thousands of acres of dry farmed fields, irrigated terrace gardens, and rangeland upon which Hopis continued to produce the majority of food consumed in their villages. This agricultural system was functioning much as it had for nearly a thousand years, having changed little since the Hopis' initial settlement of the mesas with the exception of the

²⁴ United States, *Survey of Conditions of the Indians in the United States: Hearings before a Subcommittee of the Committee on Indian Affairs, United States Senate, Seventy-First Congress, Part 18* (Washington, D.C.: United States Government Printing Office, 1932), i.

²⁵ *Ibid.*, 9314.

17th century adoption of sheep, a handful of irrigated crops, and fruit trees from Spanish invaders and the later adoption of cattle.²⁶

Gazing down from the Hopis' mesa top villages, the senators and their staff witnessed an agricultural oasis that differed substantially from the market-driven, highly mechanized farms from which Dust Bowl refugees would flee over the next decade. Despite the drought conditions that plagued the reservation throughout the 1930s, Hopi farmers and gardeners still managed to produce enough corn, beans, and squash to feed their families, with each farmer also producing a three-year surplus of corn and beans to be stored for future consumption. Terraced gardens produced abundant harvests of onions, chili peppers, and melons, and Hopi orchards displayed a vibrant bumper crop of peaches, apricots, and apples. By the end of the decade Hopis were still cultivating nearly 6,000 acres, providing their families and communities with the majority of food needed for survival in an arid and often challenging environment.²⁷

When the Senate subcommittee arrived on the Hopi mesas in May of 1931, farming, gardening, and livestock husbandry remained at the center of the Hopi universe. This did not, however, mean that Hopis were not actively participating in cash economies on and off the reservation. The sale of handicrafts including baskets, plaques, pottery, and blankets provided cash income for some individuals and families, while wage labor supported others. Some Hopis earned cash cutting wood. Others secured employment "freighting for United States," which included hauling coal, food, and other supplies to federal facilities on the reservation. Hopis also

²⁶ Alfred F. Whiting, *Ethnobotany of the Hopi* (Flagstaff, Arizona: Northern Arizona Society of Science and Art, 1939), 9.

²⁷ Frank Miller and Seth Wilson, "United States Department of the Interior, Office of Indian Affairs, Division of Extension and Industry Annual Report of Extension Workers, Hopi Indian Agency, Keams Canyon, Arizona from January 1, 1938 to December 31, 1938," February 10, 1939.

earned wages mining coal at several mines operated by the Bureau of Indian Affairs (BIA) for use by the agency and schools and building much-needed roads and bridges on the reservation.²⁸ While jobs like hauling coal and building roads were often seasonal and temporary, employment with the Bureau of Indian Affairs offered a small number of Hopis more reliable access to cash earned from wages. By 1931 the Bureau of Indian Affairs employed thirty-one Hopis at village day schools, the Hopi Agency in Keams Canyon, the hospital, and as stockmen, judges, or police.²⁹ The participation of Hopi women and men in a growing reservation wage labor economy at this time was not dissimilar to other tribes in Arizona including the Navajo and Tohono O’odham. Like these groups, Hopi men and women adapted to emerging economic shifts, took advantage of employment opportunities, and played active roles in their personal and collective integration into a cash economy.³⁰

Although some Hopis engaged in wage work during this time, the majority still earned their living through traditional farming and animal husbandry. And until the 1930s, the federal government made no attempt to change or “improve” Hopi agriculture as it had on other

²⁸ United States, *Survey of Conditions of the Indians in the United States*, 9317–9318.

²⁹ *Ibid.*, 9320–9321. For example, women began working for the agency as early as 1917, earning \$720 and \$780 per year as assistants to agency personnel. Another woman, who began working for the Bureau of Indian Affairs in 1919, earned a \$1200 salary in 1931 as a baker. The same year a Hopi women working as a nurse earned \$1800 for her labor at the Keams Canyon hospital. Hopi men worked as assistants, laborers, and more. For example, a Hopi man who worked as an assistant engineer in 1931 earned a salary of \$1560 during his thirteenth year of employment with the Bureau. Employment statistics like these formed an important piece of the Hopi economic picture that Bureau of Indian Affairs officials presented to the Senate subcommittee in the spring of 1931.

³⁰ See Colleen O’Neill, *Working the Navajo Way: Labor and Culture in the Twentieth Century* (University Press of Kansas Press, 2005); Eric V. Meeks, “The Tohono O’odham, Wage Labor, and Resistant Adaptation, 1900-1930,” *The Western Historical Quarterly* 34, no. 4 (December 2003): 468–89.

reservations during the late nineteenth and early twentieth centuries.³¹ During the 1931 hearings the subcommittee members learned from Hopi Agency Superintendent E.K. Miller of the near absence of an agricultural improvement program on the Hopi mesas. “At present,” Miller stated in a memorandum, “we have no actual technical program of advice to these Indians on farming and stock raising.”³² The superintendent, however, assured the Senators and Assistant Commissioner of Indian Affairs that the newly formed extension department was working on the matter.

It was into this semi-subsistence economy that federal reformers entered in the 1930s. Over the course of the decade and into the next, the federal government would engage in a series of projects on the Hopi Indian Reservation aimed at “improving” Hopi land, water, and agriculture.³³ These projects not only shifted agricultural practices and the management of natural resources such as soil and water, but also provided Hopis with increased opportunities to earn cash as wage laborers on conservation and construction projects. The two federal agencies spearheading the projects – the Soil Conservation Service and Bureau of Indian Affairs - worked to transform the Hopi labor and agricultural systems into institutions geared toward a cash economy, external markets, and the success of regional development projects, paying little attention to the environmental, social, or cultural constraints of the Hopi world in which they were working.

³¹ For an examination of 19th and 20th-century federal efforts to shift traditional subsistence practices toward capitalist agriculture throughout Indian Country, see Lewis, *Neither Wolf Nor Dog*.

³² United States, *Survey of Conditions of the Indians in the United States*, 9317.

³³ Chapter 3 will examine SCS and BIA water development projects, while this chapter focuses on the agencies’ attempts to reform farming and livestock practices.

Many of these programs were part of larger regional effort to curb erosion on the Hopi and Navajo Indian Reservations. In the eyes of government reformers, such erosion prohibited the successful implementation of the Colorado River Project for which President Herbert Hoover had secured congressional authorization in 1928. The Boulder Dam, which would later be known as the Hoover Dam, was an integral piece of the larger project. The dam would improve irrigation in California's Imperial Valley, secure a much-needed water supply for southern California, and generate electricity for the Southwest. Federal officials, however, perceived silt being carried downstream from the Little Colorado River on the Hopi and Navajo Reservations as an impediment to development. This silt, they argued, had the potential to amass behind the dam and sabotage its utility.³⁴ Government officials blamed overgrazing by both Hopi and Navajo Indians for the silt problem and from the 1930s through the mid-1940s implemented a series of programs and policies aimed at controlling erosion on both reservations.³⁵ While much has been written about the work of the Soil Conservation Service and Bureau of Indian Affairs on the Navajo Reservation itself during this time period, little has addressed the impact of these federal policies and programs on Hopi labor and agricultural institutions.³⁶

The Soil Conservation Service began surveying Hopi land in 1933.³⁷ Earlier that year President Franklin Roosevelt signed the Emergency Conservation Work Act into law. As the first

³⁴ White, *The Roots of Dependency*, 1988.

³⁵ See Marsha Weisiger, *Dreaming of Sheep in Navajo Country* (Seattle: University of Washington Press, 2009) for a cultural and environmental analysis of these issues on the Navajo reservation.

³⁶ Both White and Weisiger address these issues from a Navajo perspective with little mention of the Navajos' Hopi neighbors. See White, *The Roots of Dependency*, 1988; Weisiger, *Dreaming of Sheep in Navajo Country*.

³⁷ "Long Range Program for the Hopi Tribe, Arizona, March 1944," March 1944, RG 75 Records of the Bureau of Indian Affairs, Records of the Branch of Tribal Programs, Ten Year Plans, ca. 1943-44, Grand Ronde-Siletz to Kiowa, Box 3, E1014B, National Archives I.

major New Deal work relief act passed by Congress, the legislation authorized “the restoration of the country's depleted natural resources and the advancement of an orderly program of useful public works.”³⁸ Five days after signing the act the President issued Executive Order 6101, which effectively formed what would eventually be known as the Civilian Conservation Corps. The order provided funding and bureaucratic structure necessary for the employment of the nation’s unemployed on Emergency Conservation Work (ECW) projects on federal lands – including Indian reservations – across the country.³⁹

By the end of the year the Indian Emergency Conservation Work (IECW), which would later become the Civilian Conservation Corps-Indian Division (CCC-ID), was operating throughout Indian Country. In Arizona and throughout the country, employees of the Soil Erosion Service, which would soon become the Soil Conservation Service (SCS), fulfilled the majority of duties of district CCC offices thereby linking the labor performed by Hopi men with the objectives of the SCS.⁴⁰ On the Hopi and Navajo reservations between 1933 and 1938, IECW crews constructed and repaired roads, developed surface- and groundwater projects, planted invasive species as erosion control measures, and poisoned grasshoppers and prairie dogs. Like the more than 60,000 American Indian men from twenty-four reservations who participated in the IECW and CCC-ID, participation in these programs served as their introduction to wage

³⁸ Donald L. Parman, *The Navajos and the New Deal* (New Haven: Yale University Press, 1976), 32–35.

³⁹ Franklin D. Roosevelt: "Executive Order 6101 Starting The Civilian Conservation Corps," April 5, 1933. Online by Gerhard Peters and John T. Woolley, *The American Presidency Project*. <http://www.presidency.ucsb.edu/ws/?pid=14609>.

⁴⁰ Donald Lee Parman, “The Indian Civilian Conservation Corps” (Ph.D., The University of Oklahoma, 1967), 183–4.

labor.⁴¹ By 1942 wages earned primarily by young Hopi men comprised, for the first time, a higher percentage of overall cash income on the reservation than proceeds from livestock sales.⁴² During that year, Hopis earned the majority of their wages by working for either CCC-ID or Soil and Moisture Conservation Operations, whose predecessor was the Soil Conservation Service.⁴³

The first IECW crew on the Hopi Indian Reservation formed in 1933 under the leadership of Edward T. Hall. In the late spring of 1933 Hall, a sophomore anthropology major at the University of Denver, received a telegram from United States Commissioner of Indian Affairs John Collier. In the telegram Collier offered Hall a job “working on an Indian Reservation as part of a new and innovative program.” Hall, a friend of the Commissioner’s sons, quickly accepted a position supervising IECW and later CCC-ID crews of Hopis and Navajos on both Hopi and Navajo lands.⁴⁴ Hall’s first assignment was to lead a crew of fifteen Hopi men to “fix the worst part of the road next to the sacred Corn Rocks, a prominent pair of tall, thick sandstone pillars” on the road that led up Second Mesa to the village of Mishongnovi.⁴⁵ There, according to Hall, the “road was nothing but tracks and grooves made by wagon wheels, weaving in and out of boulders and up over rock ledges at impossibly steep inclines.” While working, the Hopi men spent much of their time asking Hall detailed questions about the ECW program. How was it set

⁴¹ For an overview of the Indian Division of the Civilian Conservation Corps, see Donald L. Parman, “The Indian and the Civilian Conservation Corps,” *Pacific Historical Review* 40, no. 1 (February 1971): 39–56. For a comparative example that explores wage labor, IECW, and the CCC-ID on the Wind River Reservation in Wyoming, see Brian Hosmer, “‘Dollar a Day and Glad to Have It’: Work Relief on the Wind Indian Reservation as Memory,” in *Native Pathways: American Indian Culture and Economic Development in the Twentieth Century*, ed. Brian Hosmer, Colleen O’Neill, and Donald L. Fixico (Boulder: University Press of Colorado, 2004), 284.

⁴² “Long Range Program for the Hopi Tribe, Arizona, March 1944,” 27.

⁴³ *Ibid.*, 27, 36.

⁴⁴ Edward T. Hall, *West of the Thirties: Discoveries among the Navajo and Hopi* (New York: Doubleday, 1994), 3–4.

⁴⁵ Hall, *West of the Thirties: Discoveries among the Navajo and Hopi*, 22.

up? What purposes did it serve? What part would Hopis play in deciding where projects would be located? And how would these projects be chosen?⁴⁶

The questions these men raised and their willingness to work for wages on ECW projects exemplify the active roles Hopis played in the transition from a semi-subsistence economy to one rooted in cash. Economic change on the Hopi reservation was a negotiated process. In his memoir, Hall argues that IECW and CCC-ID laborers were, “happy to have work for which they were well paid,” and that these jobs, “gave them much-needed cash on which to live as well as money to repay debts to the traders.”⁴⁷ While Hall’s rosy recollection may have been true for some Hopis that worked on IECW and CCC-ID projects, not all workers were in total alignment with the government projects on which they worked or the development of resources they utilized as farmers and shepherds. Take, for example, the testimony of Simon Scott from the Third Mesa village of Hotevilla, who spoke about his experience with IECW during hearings held in 1955 by the Bureau of Indian Affairs Phoenix Area Office. As a 35-year-old, Scott began working on IECW projects in 1934 across Hopi and Navajo lands including the Red Lake area, Oraibi, Mishongnovi, and Keams Canyon. “Working on these projects I began to learn more things, trying to stick to the teachings I have obtained from my schooling and my people,” he recalled. “But it seems that things turned out wrong.”⁴⁸ In his world, things like water development and the reduction of Hopi livestock – both major components of what Scott saw as

⁴⁶ Ibid., 23.

⁴⁷ Ibid., 48.

⁴⁸ United States, *Hopi Hearings, July 15-30, 1955* (Keams Canyon, Ariz: The Bureau, 1955), 30.

the “great plan” of the Bureau of Indian Affairs and Soil Conservation Service – went terribly wrong as the agencies unfurled projects throughout Hopi lands during the 1930s and 1940s.⁴⁹

Between 1933 and 1934 the Soil Conservation Service began making surveys of Hopi land, and the agency was soon working cooperatively with the Civilian Conservation Corps-Indian Division to treat areas of land they deemed in need of erosion control measures.⁵⁰ Earlier that year the agency declared that “the depletion of the vegetative cover by improper use” was a primary cause of what they termed “accelerated erosion.” In doing so, the Navajo District of the Soil Conservation Service found it necessary to restore vegetative cover “in order to effectively aid in stopping soil and water wastage.”⁵¹ As such, Soil Conservation Service personnel planted quick-growing, non-native species such as Virginia creeper, wild olive, Siberian pea tree, and Russian olive for erosion control. In addition, special grazing regulations for both Hopi and Navajo went into effect July 1, 1937. Federal officials established boundaries for eighteen administrative units across the two reservations in order to execute the agency’s land and stock management program. The creation of the units also, for the first time, allowed federal agents to determine the livestock carrying capacity for each unit.⁵²

In early 1938, the Soil Conservation Service and Bureau of Indian Affairs reached a Memorandum of Understanding for cooperative erosion control and land management activities on Navajo and Hopi lands. The “major considerations” of the interagency work that would

⁴⁹ Hall, *West of the Thirties: Discoveries among the Navajo and Hopi*, 38.

⁵⁰ “Long Range Program for the Hopi Tribe, Arizona, March 1944.”

⁵¹ U.S. Department of Agriculture Soil Conservation Service, “Navajo District Annual Report 1937-1938, U.S. Department of Agriculture Soil Conservation Service, Region 8,” 1938, RG 75 Records of the Bureau of Indian Affairs: Soil and Moisture Conservation Operations: Records Relating to Navajo Soil Conservation Activities, ca. 1933-50, Box 1, National Archives I.

⁵² *Ibid.*

follow as a result of this agreement included the “restoration” of Indian lands from “erosion, resulting largely from overgrazing,” the “partial protection of the storage capacity of Lake Mead, to which this area is a heavy silt-contributor,” and assuring the “sustained welfare of the Indians on the lands available for their use.” As such, government agents would strive to “(1) restore and conserve soil, water and other natural resources; (2) provide for the best permanent use of farm, forest, and range lands; and (3) reduce the silt load of the Little Colorado and San Juan Rivers.”⁵³

It was under the auspices of this agreement that the Bureau of Indian Affairs and the Soil Conservation Service began what would become a decade-long effort to “improve” Hopi agriculture, livestock management practices, and water resources. This trajectory of agricultural improvement initially took little consideration of the harsh desert environment or the culture that had been cultivating its sands for over a thousand years. Instead, federal policies and programs aimed to incorporate Hopi agriculture and labor into a system linked to national markets and regional development projects like the Boulder Dam without consideration of internal sustainability.

In 1939 the Soil Conservation Service began making plans for its Erosion Control Program, one of the agency’s first projects on Hopi lands that directly affected farmers. Prior to the program’s formulation and implementation, agency officials produced in 1938 a set of “Recommended Erosion Control Measures on Dry Farms for the Reservation.” These

⁵³ The Bureau of Indian Affairs, U.S. Department of the Interior and The Soil Conservation Service, U.S. Department of Agriculture, “Memorandum of Understanding between The Bureau of Indian Affairs, U.S. Department of the Interior and The Soil Conservation Service, U.S. Department of Agriculture Relative to: Cooperative Erosion Control and Land Management Activities on Grazing, Timber, and Agricultural Lands Administratively Controlled by the Bureau of Indian Affairs, within the Boundaries of the Navajo and Hopi Reservations,” 1938, RG 75 Records of the Bureau of Indian Affairs: Soil and Moisture Conservation Operations: Records Relating to Navajo Soil Conservation Activities, ca. 1933-50, Box 1, Folder: “Soil Conservation: Navajo 1933-38,” National Archives I.

recommendations included the “construction of level terraces on erosive slopes” that would be planted with “native grasses, permanent pasture grass mixtures, and small grains” to conserve water and prevent further erosion or gullyng. Officials also recommended contour cultivation and contour listing for row crops, the introduction of soil saving equipment, and the replacement of “non-erosion resisting crops” with non-Hopi crops that would resist erosion.⁵⁴ These methods were not born of a particular Hopi problem to be solved, but were rather transplanted to the mesas from faraway places by the Soil Conservation Service. Contouring and terracing, for examples, were key components of SCS work in humid states as well as semiarid Texas wheat fields.⁵⁵ This is reflective of what historian Deborah Kay Fitzgerald terms a “transfer mentality” in which the industrialization of agriculture in the United States spawned agricultural experts who sought uniform solutions to common problems in diverse places.⁵⁶ On the Hopi reservation, such proposed solutions were implemented with little overall success.

In 1939, under the technical supervision of the Soil Conservation Service, federal agents began a series of programs aimed at improving Hopi soil management practices through shifting indigenous methods of cultivation, implementing the practice of systemic crop rotation, and urging Hopis to use fertilizer. Extension Agent Joseph Hall argued that, “the application of these farm practices to Hopi agriculture, each of which has a separate value in relation to sustained productivity, seems of primary importance to a sound agricultural program.”⁵⁷ Hall and his associates saw the implementation of “practices designed to increase fertility” as important as

⁵⁴ U.S. Department of Agriculture Soil Conservation Service, “Navajo District Annual Report 1937-1938, U.S. Department of Agriculture Soil Conservation Service, Region 8.”

⁵⁵ Worster, *Dust Bowl*, 1979, 210–30.

⁵⁶ Fitzgerald, *Every Farm a Factory*, 186–8.

⁵⁷ Joseph K. Hall and Seth Wilson, “1939 Annual Narrative Summary of Extension Work, Hopi Indian Agency,” February 12, 1940.

changing the farming methods employed by Hopis, including planting and techniques to check wind erosion. The latter, according to Hall, was in dire need of improvement.

The Soil Conservation Service demonstrated “improved” methods of planting to Hopi farmers using Bureau of Indian Affairs Irrigation Department tractors, a tractor listor, and several horse-drawn listors. The listor was a technological implement developed to plant seeds in a deep furrow, leaving mounds of four to five inches of soil on each side of the furrow so that when rains fell the moisture would settle on the seeds. With this equipment, Soil Conservation Service employees “provided the necessary technical supervision to list a number of Hopi farms” in the fall of 1939 with the hope of fostering widespread acceptance of these practices by 1940.⁵⁸

By the spring of 1940 the Erosion Control Program was formally operating on nearly 12,000 acres of dry farmed Hopi fields.⁵⁹ Extension Agent Joseph Hall reported that 248 “man-days of contributed Indian labor were expended in treating the reservation cultivation areas, in addition to buffer strips adjacent to the farm land.”⁶⁰ Bureau of Indian Affairs and Soil Conservation Service agents worked with Hopis to shift their farming practices away from traditional dry farming toward strip farming, a technique used in multiple regions of the country during the Dust Bowl years to discourage erosion.⁶¹

⁵⁸ Ibid.

⁵⁹ Joseph K. Hall, “1940 Annual Narrative Summary of Extension Work, Hopi Indian Agency,” February 1941.

⁶⁰ Ibid.

⁶¹ Miller and Wilson, “United States Department of the Interior, Office of Indian Affairs, Division of Extension and Industry Annual Report of Extension Workers, Hopi Indian Agency, Keams Canyon, Arizona from January 1, 1938 to December 31, 1938”; Hall and Wilson, “1939 Annual Narrative Summary of Extension Work, Hopi Indian Agency”; For comparative examples of the use of strip farming as an SCS technique in the southern plains, see Worster, *Dust Bowl*, 210–30.

The attempt to implement strip farming as a practice amongst Hopis was ultimately unsuccessful, but, over the next several decades, the introduction of technology that accompanied these efforts would slowly translate into the most significant technological change in the history of Hopi farming. In 1944 several Hopi farmers purchased two tractors – the first by a First Mesa farmer and the second by a group of farmers from Second Mesa.⁶² The farmers used the tractors, complete with cultivator attachments, to engage in a limited attempt at strip farming. Despite this attempt, government officials reported two years later that there had been no further progress in strip cropping on the Hopi Indian Reservation.⁶³ It had failed to supplant the ancestral practices rooted on the Hopi mesas. This lack of federal success was not unlike other SCS attempts to augment indigenous agricultural practices in Arizona, like the agency's failed attempt to institute closed-basin agriculture on the Tohono O'odham reservation.⁶⁴ In both cases indigenous farmers failed to adopt agricultural techniques developed for other regions.

The Soil Conservation Service also introduced chemical technologies into the Hopi agricultural system during the 1930s and 1940s. This introduction included the application of fertilizers in Hopi fields and pesticides in the orchards. In 1938 federal agents reported that, “tree spraying and pruning is not generally accepted, but practiced by a few of the younger

⁶² It is unclear how these farmers acquired the capital for such a purchase, but it is likely that they utilized cash earned from wage work and/or the Bureau of Indian Affairs Division of Extension and Industry credit program.

⁶³ Eugene D. Lowery and Burton A. Ladd, “1944 Annual Report of Extension Work, Hopi Indian Reservation,” December 31, 1944; Burton A. Ladd, “1946 Annual Report of Extension Work, Hopi Indian Reservation,” December 31, 1946.

⁶⁴ Henry F. Dobyns, “Blunders with Bolsas: A Case Study of Diffusion of Closed-Basin Agriculture,” *Human Organization*, Fall 1951, 25–32.

generation.”⁶⁵ Despite multiple attempts over the next decade, SCS and BIA officials were unsuccessful in implementing a program of chemical application in Hopi orchards. As BIA Range Supervisor Burton Ladd reported in 1946, “advice was offered but unheeded.”⁶⁶

While Hopis did not adopt chemical technology in their orchards, many participated in the application of chemicals to eliminate insects and rodents known to plague Hopi farmers. In 1947 the BIA secured poisoned grain from the Fish and Wildlife Department for the purpose of rodent control. According to that year’s report of extension work, “farmers organized into groups in relation to the areas where they lived and farmed or had gardens planted, and the poisoned grain was distributed by them under proper supervision.”⁶⁷ The following year federal agents supervised Hopi farmers and gardeners in the application of 500 pounds of “grasshopper poison” at Wepo Springs.⁶⁸ When these examples are considered alongside the orchardists’ refusal to adopt chemical technologies, they demonstrate the active roles played by Hopi farmers during this period of federal reform and the process of selective adaptation. In one case, Hopis chose to not incorporate the advice of federal agents, as it did not serve them. In the case of pest control, Hopi farmers willingly participated in projects aimed at reducing the number of rodents and insects that negatively affected farming and gardening practices.

The joint efforts of the Bureau of Indian Affairs and the Soil Conservation Service on the Hopi Indian Reservation during the 1930s and 1940s also included efforts to resettle Hopi families on communal irrigated farm tracts where they would cultivate forage crops for livestock

⁶⁵ Miller and Wilson, “United States Department of the Interior, Office of Indian Affairs, Division of Extension and Industry Annual Report of Extension Workers, Hopi Indian Agency, Keams Canyon, Arizona from January 1, 1938 to December 31, 1938.”

⁶⁶ Ladd, “1946 Annual Report of Extension Work, Hopi Indian Reservation.”

⁶⁷ Darrell P. Young, “1947 Annual Report of Extension Work,” December 31, 1947.

⁶⁸ “1948 Annual Report of Extension Work, Hopi Indian Reservation,” December 31, 1948.

and crops to be sold in external markets. The first of these experiments included the resettlement of Hopi families to irrigated farm projects in two of the Hopi Reservation's major wash systems. Beginning in 1940, both Soil Conservation Service and Bureau of Indian Affairs personnel worked to relocate around twenty Hopi families to the Phillips Farms and Jeddito projects, where farmers tended individual garden plots to feed their families as well as engaged in communal irrigated farming efforts. This included the production of alfalfa for livestock feed.⁶⁹

Phillips Farms depended on irrigation water from perennial springs in the bed of Polacca Wash. An extensive irrigation system was built to pump the water from the wash to the bench above, where it then traveled through earthen ditches to plowed fields. Unlike its sister farm, the Jeddito project depended on flood runoff from the Jeddito Wash for irrigation. Government agents, likely with the help of Hopis employed by the Civilian Conservation Corps-Indian Division, constructed flood control gates, which then diverted the floodwaters. A third experiment, the Hardrock Project in Oraibi Wash, was also underway by 1944 when government agents reported that the harvest and associated cash income from all three projects was quite low, a direct result of the limited amount of water available and the reluctance of Hopi dry farmers to participate in irrigation projects. By 1946 officials reported that nothing, save for numerous repairs to the dikes and floodgates, had been accomplished and the projects were soon abandoned.⁷⁰

By 1950, over a decade after the initial attempts to improve Hopi farming were first initiated, federal officials arrived at the conclusion that traditional Hopi farming methods were far more environmentally and technologically appropriate than the Western techniques and

⁶⁹ "Long Range Program for the Hopi Tribe, Arizona, March 1944."

⁷⁰ Lowery and Ladd, "1944 Annual Report of Extension Work, Hopi Indian Reservation;" Ladd, "1946 Annual Report of Extension Work, Hopi Indian Reservation."

technologies with which they sought to replace them. As one Extension agent put it, “The agricultural practices employed are somewhat primitive in nature, but as such have proven best suitable to the climatic conditions of the area over centuries.... Since there is no possibility of developing any practical or large scale irrigation projects on the Hopi Reservation, it would not be wise to attempt any drastic or overall reforms in the agricultural practices of the Hopi people at this time.”⁷¹ This sentiment mirrors that of federal agents working to reform agriculture on the Tohono O’odham reservation earlier in the century. As one reformer wrote, “Any attempt to introduce modern farming methods... would result in disaster.”⁷²

While government reformers’ efforts to Westernize Hopi farming were ultimately a failure, a series of federal interventions into indigenous livestock practices resulted in substantial changes for Hopi herds, flocks, and the men who tended them. In the late 1930s the Bureau of Indian Affairs began the long, arduous process of incorporating Hopi sheep and cattle into the capitalist marketplace on both regional and national levels. Like the efforts to transform farming, government programs targeting Hopi sheep and cattle were rooted in a larger regional web of economic development for the Southwest as a whole, as exemplified by BIA and SCS efforts to reduce Hopi and Navajo livestock in order to curb erosion so that the Boulder Dam might function according to plan. Reformers also sought to “improve” the remaining herds through better breeding and livestock management practices, and market these animals. This tripartite approach on the part of the Soil Conservation Service and Bureau of Indian Affairs aimed to

⁷¹ Hopi Indian Agency, “Annual Report of Extension Work, Calendar Year 1950,” Folder 15, Collection 145, 8.

⁷² Lewis, *Neither Wolf Nor Dog*, 147.

transform Hopi livestock from animals whose purpose was to fulfill the subsistence needs of local people to exportable commodities in a national, even global marketplace.⁷³

In 1938, sheep and goats collectively outnumbered cattle by ten to one on the Hopi mesas, and no formal livestock or marketing associations existed on the reservation.⁷⁴ Sheep and goats played an important role in Hopi economic life, providing meat for local consumption. Hopis utilized the wool from their sheep, weaving it into numerous articles for both home use and sale to local traders. Surplus wool provided a good cash crop as it was sold along with tanned pelts that were not designated for home use. Cattle, which first made their way into the Hopi economy in the late 19th century, played a comparatively minimal role in Hopi animal husbandry, serving primarily as a cash-generating commodity for a small number of Hopi men who sold steers and yearlings locally to off-reservation buyers and local traders who competed with one another for the best price.⁷⁵

In 1938 Bureau of Indian Affairs officials held meetings on the Hopi Indian Reservation to discuss “improving” Hopi livestock management “by the introduction of pure-bred sires, compliance with breeding dates, and cooperation in soil conservation and range management so as to be able to utilize water and feed to the best advantage to all herd and flock owners.”⁷⁶ Drought-stricken in August of the following year, Hopis voluntarily sold 148 cattle to a speculator for prices so low that a dismayed Extension Agent Joseph Hall declared “an

⁷³ Hall and Wilson, “1939 Annual Narrative Summary of Extension Work, Hopi Indian Agency.”

⁷⁴ Miller and Wilson, “United States Department of the Interior, Office of Indian Affairs, Division of Extension and Industry Annual Report of Extension Workers, Hopi Indian Agency, Keams Canyon, Arizona from January 1, 1938 to December 31, 1938.”

⁷⁵ Ibid.

⁷⁶ Ibid.

educational marketing program was badly needed.”⁷⁷ With Superintendent Seth Wilson’s approval, the agent devoted nearly all extension work in the following two months, “to the task of getting Indian stockmen interested in sending a shipment of cattle to a central competitive market.”⁷⁸ In the fall of 1939, eleven Hopi cattlemen accompanied six railcars of cattle totaling 268 head (owned by twenty-three cattlemen) to the Los Angeles Union Stock Yards where the animals netted 185% over the prices earned by Hopi sellers on the reservation back in August. These sales reduced the cattle population by 19%, supporting the federal government’s goal of livestock reduction among the Hopi that would not reach its apex until the 1940s.⁷⁹ Hopi stockmen like Roger Quoihytewa, who was one of the eleven who accompanied the cattle to Los Angeles in 1939, were supportive of Hall and the new marketing program and would go on to help start the Hopi Stockmen’s Union the following year.⁸⁰

While Hopi cattle made their way to Los Angeles, Hopi sheep headed north by rail to the stockyards of Denver, Colorado. After Bureau of Indian Affairs efforts to auction off Hopi sheep via local buyer competitive bidding failed, four Hopi shepherds accompanied several railcars of sheep to Denver where they were subsequently sold. As a result of both the sheep and cattle cooperative livestock shipments that transpired during the fall of 1939, Agent Hall noted that 45 Hopi sheep and cattle owners were, “taking an active interest in the marketing of Hopi livestock by cooperative effort.”⁸¹ Hall felt that these men would be sympathetic to the 1940 livestock program, which would entail further reduction of Hopi herds through cooperative marketing

⁷⁷ Hall and Wilson, “1939 Annual Narrative Summary of Extension Work, Hopi Indian Agency.”

⁷⁸ Ibid.

⁷⁹ Ibid.

⁸⁰ United States, *Hopi Hearings, July 15-30, 1955*, 192–6.

⁸¹ Hall and Wilson, “1939 Annual Narrative Summary of Extension Work, Hopi Indian Agency.”

strategies such as those implemented in 1939. Hall also stated that, “the emergency arising from the drought, necessitating voluntary reduction by sale, or the inevitable losses which would have resulted had no considerable reduction been made, found the Hopi, encouraged by fair prices, going further in the direction of reduction than would have been the case had the old pattern of marketing continued.”⁸² Here ecological circumstance worked in the favor of government reformers.

The following year Hopis participating in the new livestock programs, like Roger Quoihytewa, worked with Hall to form the first Hopi livestock association, known as the Hopi Stockmen’s Union.⁸³ At the same time, the Bureau of Indian Affairs began implementing a herd improvement program that included controlled breeding with purebred sires, improved range management, and the continued marketing and shipment of Hopi cattle and sheep to regional markets in Los Angeles and Denver. In addition, Bureau officials worked to institute a program of supplemental livestock feeding in which certain animals, especially the purebred sires, were provided with additional fodder to improve their sexual performance. This objective dovetailed with the Bureau’s irrigation project at Jeddito and soon Hopis working there were raising alfalfa for local livestock.⁸⁴ Similar programs were instituted on Indian lands throughout Arizona and the western United States, including the Tohono O’odham, San Carlos Apache, Navajo, White Mountain Apache, Lower Brule, and Pine Ridge reservations and, as Peter Iverson points out, many Indians benefited from these programs.⁸⁵ Historian Alison R. Bernstein, on the other hand,

⁸² Ibid.

⁸³ United States, *Hopi Hearings, July 15-30, 1955*, 192–6.

⁸⁴ Hall, “1940 Annual Narrative Summary of Extension Work, Hopi Indian Agency.”

⁸⁵ Peter Iverson, *When Indians Became Cowboys: Native Peoples and Cattle Ranching in the American West* (Norman: University of Oklahoma Press, 1994), 116–150.

argues that such forms of tribal economic development encouraged a type of “corporate assimilation.”⁸⁶ On the Hopi reservation, both views are reflected.

From an archival perspective, the Bureau of Indian Affairs’ livestock improvement program appears to have been successful throughout the early part of the 1940s. Hopis had formed four Bureau-approved livestock associations including the Hopi Stockmen’s Union (1940), the Polacca Stockgrowers Association (1941), the Hopi Tribal Ram Distribution Enterprise (1942), and the Second Mesa Livestock Association (1943), were participating in herd improvement through controlled breeding, and were seeing increased financial returns from external marketing strategies.⁸⁷ Federal agencies rewarded such cooperation. A First Mesa stockman recalled that the Polacca Stockgrowers Association was awarded the Conservation Service Award from the U.S. Department of the Interior, “for being very cooperative in Soil Conservation programs, which we are very proud of.”⁸⁸

Despite the participation of some Hopis in the Bureau’s program and their collaboration in voluntary livestock reduction through organized sales, federal officials deemed a mandatory reduction of all Hopi livestock was necessary. By 1943 the Hopi Reservation was in the throes of an extreme drought and it was in the midst of this environmental crisis that Bureau of Indian Affairs officials mandated a 24% reduction of livestock.⁸⁹ Beginning in the fall of 1943 the Bureau instituted a “livestock adjustment program” on the Hopi Mesas, resulting in a dramatic shift in animal populations on the mesas. When compared with pre-reduction figures from 1942,

⁸⁶ Alison R Bernstein, *American Indians and World War II: Toward a New Era in Indian Affairs* (Norman: University of Oklahoma Press, 1991), 19.

⁸⁷ Lowery and Ladd, “1944 Annual Report of Extension Work, Hopi Indian Reservation.”

⁸⁸ United States, *Hopi Hearings, July 15-30, 1955*, 371.

⁸⁹ Richard Clemmer, *Roads in the Sky: The Hopi Indians in a Century of Change* (Boulder: Westview Press, 1995).

livestock populations in 1950 were but a shadow of their former selves. Sheep that once grazed the mesas in herds numbering nearly 25,000 were reduced to around 11,000 by 1950. The Hopi goat population suffered an even more devastating blow, with their numbers dropping from over 1,700 in 1942 to a mere 28 goats in 1950.⁹⁰ This extreme decline is likely a result of goats being disproportionately targeted by federal agents for reduction due to their minimal market value as Marsha Weisiger argues was the case on the Navajo reservation.⁹¹

While Hopi sheep and goats suffered and collectively declined as a result of both stock reduction and drought, the cattle population on the reservation quickly rebounded after the federally mandated 1943-44 reduction and steadily increased throughout the remainder of the decade. By 1950 Hopi cattle numbered around 3,000, a figure nearly double their immediate post-reduction numbers.⁹² Through the twentieth century, sheep and goat populations would steadily decline until the last herd of sheep was sold from the mesas in the 1990s. Cattle would eventually replace sheep altogether, a transition that had both economic and social roots and implications.⁹³

With the exception Virginia Wilson's 1993 Master's thesis, scholars have not fully addressed the implications of stock reduction for Hopi culture and economy. Only two interviews are known to have been conducted with individuals who experienced the reduction and the Bureau of Indian Affairs archival files, which were in a "shocking state of mis-maintenance and disrepair" when Wilson examined them over twenty years ago have since

⁹⁰ "1951 Annual Report of Extension Work," January 15, 1951.

⁹¹ Lowery and Ladd, "1944 Annual Report of Extension Work, Hopi Indian Reservation"; "1951 Annual Report of Extension Work," January 15, 1951; Weisiger, *Dreaming of Sheep in Navajo Country*, 162.

⁹² Eugene D. Lowery and Burton A. Ladd, "1945 Annual Report of Extension Work, Hopi Indian Reservation," December 31, 1945; "1951 Annual Report of Extension Work."

⁹³ Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

disappeared from their former repository in Keams Canyon, Arizona.⁹⁴ The limited research Wilson was able to conduct due to minimal archival sources and the failure to secure a permit from the Hopi Tribe to conduct oral history interviews resulted in a study that, while limited, provides some important insights into how Hopis experienced stock reduction. According to Wilson, stock reduction depleted the cash economic base of many families, as they no longer had wool to sell as a major cash crop. In addition, sheep served as a major source of food for many Hopi families. As a result of the reduction, many families had to spend more of their diminished cash stores on food from local trading posts, and the reduction resulted in a diminished local sheep trade with other nearby tribes and whites. Wilson argues that these material changes produced sociocultural changes including an increased need for wage work and the separation and scattering of families and clans as they sought off-reservation employment opportunities.⁹⁵

These arguments are supported by the testimonies given by Hopi men and women at hearings held by the Bureau of Indian Affairs Phoenix Area Office in Hopi villages during the summer of 1955. The purpose of the hearings was, in part, to assess Hopi perspectives on federal programs. During the hearings, the topic of stock reduction came up again and again, revealing the deep cultural and economic wounds Hopis suffered as a result of this federal policy. At the Hotevilla hearings, several men spoke of their experiences being jailed for several months because they refused to accept stock permits in 1945. “I spent 90 days in jail,” a Hopi named George testified, “and lost all of my sheep and horses because I want to live my own way of life and adhere to my Hopi religious teachings.”⁹⁶ Rubin Cheykaychi, who was one of the men jailed

⁹⁴ Virginia Wilson, “How Many Sheep Are Too Many?: A Documentary Study of the Sociocultural Impact of the Livestock Reduction Program on the Hopi” 1993.

⁹⁵ *Ibid.*, 135-6.

⁹⁶ United States, *Hopi Hearings, July 15-30, 1955*, 13–14.

for his resistance, testified to the economic effects of stock reduction. “I did not know how to take care of my family because all stock was taken from. It seems the food was taken from my mother.”⁹⁷

Women, too, suffered as men were jailed and livestock reduced. A Hotevilla woman whose son was jailed for evading stock permits recalled the day a policeman came and took her and her daughter-in-law to the sheep corral, instructing them to pick out her son’s sheep. It was a hot day, and the younger woman was pregnant. The two were then forced to walk several miles and herd the sheep. “This I can never forget,” she testified in 1955. “This will be with me always. These are the sufferings created under these programs.”⁹⁸ Her testimony, ten years after the incident, reveals the deep emotional wounds that stock reduction carved into Hopi society. Such scars are similar to those bore by the Hopis’ Navajo neighbors. Marsha Weisiger argues that on the Navajo reservation, stock reduction resulted in a “collective memory of trauma” and a “long-lasting rejection of range conservation policies,” both of which can be heard in the voices of Hopi men, women, and children.⁹⁹ This historical trauma has remained with Hopis in the twenty-first century as evidenced by the oral history testimony of one Hopi man. In the 1940s this man was a young boy who herded sheep with his grandfather. His family’s sheep were reduced from around 350 to 65. “That was real hard for my grandma because she depended on them. We all depended on them,” he told me. The sheep served as a source of income for the

⁹⁷ Ibid., 15.

⁹⁸ Ibid., 17.

⁹⁹ Weisiger, *Dreaming of Sheep in Navajo Country*, xv.

family who, following the annual summer shearing, “took the wool over to the Oraibi Trading Post where we could sell it...that’s our source of income at that time.”¹⁰⁰

The economic hit Hopis suffered from stock reduction had lasting effects, making it difficult for young men make a living raising livestock. While the entrance of the United States into World War II and the subsequent mobilization of the American war machine provided economic opportunities for many Hopis during the 1940s, those returning after the war’s end found limited opportunities in both livestock and wage labor as government programs like the Indian CCC-ID were terminated.¹⁰¹ A Hopi man from the village of Mishongnovi spoke to the difficulties he faced as a father with six sons returning from the war. “They have no means of supporting their families,” he testified to government officials in 1955. “My boys all have families now and as is only natural, they depend on me as their father. I have only a few sheep and want to help my boys all I can, but just a few head of sheep makes it quite difficult for me to be able to do much for them.” Another veteran expressed a similar sentiment in the village of Mishongnovi. “When I went into the Service I went with the hope that some day I would come back to my land, would be able to re-establish myself in civilian life, and would be able to have a sufficient means of providing for myself,” he testified. “These were my hopes and these were my expectations. However, much to my regret when I came home I found that heartaches were awaiting me.”¹⁰²

The sons about whom the first man spoke were among a large number of Hopis who returned to the mesas after World War II to discover that stock reduction had significantly

¹⁰⁰ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, August 17, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

¹⁰¹ Parman, “The Indian and the Civilian Conservation Corps,” 54.

¹⁰² United States, *Hopi Hearings, July 15-30, 1955*, 140.

altered Hopi lives, economic affairs, and opportunities. When examined side-by-side, stock reduction and the end of World War II constitute significant historical shifts on the Hopi mesas. Historians and anthropologists agree the Second World War had a profound effect not just on Hopis, but also throughout Indian Country.¹⁰³ The wartime economy spawned new work for American Indians off the reservation, and by conflict's end 40,000 had left their homes for employment in war-related industries.¹⁰⁴ At least one-third of tribal members left the Hopi mesas during WWII for active duty in the armed forces or work in war-related industries. Several hundred Hopi men served in the armed forces and numerous others, men and women alike relocated to towns such as Winslow and Flagstaff for employment in the railroad and other war-related industries. Children also left the reservation with their parents, like a rancher and farmer from Tewa Village I interviewed. He left the reservation for the town of Winslow when his father took a job with the Santa Fe Railroad in 1942.¹⁰⁵ By the war's end, wages like those earned by his father comprised 36% of cash entering the Hopi reservation, with livestock sales at 22% and the sale of arts and crafts at 3%.¹⁰⁶

¹⁰³ Bernstein, *American Indians and World War II*; Tom Holm, "Fighting a White Man's War: The Extent and Legacy of Indian Participation in World War II," in *The Plains Indians of the Twentieth Century*, ed. Peter Iverson (Norman: University of Oklahoma Press, 1986); Peter Iverson, *The Plains Indians of the Twentieth Century* (Norman: University of Oklahoma Press, 1986), 149; Edward A. Kennard, "Post-War Economic Changes among the Hopi," in *Essays in Economic Anthropology: Proceedings of the 1965 Annual Spring Meeting of the American Ethnological Society*, ed. June Helm and Karl Polanyi (Seattle: University of Washington Press, 1965), 24–32.

¹⁰⁴ Bernstein, *American Indians and World War II*, 68.

¹⁰⁵ Tewa man, interview by author, Tewa Village, Arizona, November 8, 2013.

¹⁰⁶ Clemmer, 169, 171; Edward A. Kennard, "Post-War Economic Changes Among the Hopi," in *Essays in Economic Anthropology: Proceedings of the 1965 Annual Spring Meeting of the American Ethnological Society*, ed. June Helm (Seattle: University of Washington Press, 1965), 26.

Hopi veterans returning from the war found work in a variety of construction-related industries, utilizing the technical training they had received during the conflict. Many of these men procured employment on the road construction projects implemented throughout the reservation by the Bureau of Indian Affairs in a variety of positions, including heavy equipment operators. Others were able to find work off the reservation for corporations such as the Santa Fe Railroad¹⁰⁷.

Hopis procured employment in both the public and private sectors during the 1950s. By 1953 63% of family income was generated by wages, and 500 of the 720 families living on the reservation were engaged in either part-time or full-time wage work. The limited employment opportunities on the Hopi reservation resulted in family members leaving their homes to work in both the private and public sectors. While some found seasonal work in the tourism industry, others sought employment with federal agencies such as the U.S. Forest Service. These Hopis procured seasonal employment as tree trimmers and firefighters, enabling them to earn cash that would make its way into the reservation economy.¹⁰⁸

The stories of Hopis involved in wage labor during this time period reveal the degree of historical agency they exercised. For many, employment in the capitalist marketplace was a choice, and they freely explored these options in a variety of sectors. Their experiences often parallel with those of American Indians throughout the United States during the twentieth

¹⁰⁷ Rushforth and Upham, *A Hopi Social History*.

¹⁰⁸ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, August 17, 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona; Hopi man, interview by Tai Johnson, July 6, 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona.

century, particularly in their roles as agents and negotiators of change as well as the active adaptation of indigenous institutions.¹⁰⁹

The introduction of wage labor into the lived experiences of Hopi families impacted the ways in which men and women participated in both the traditional subsistence economy and the evolving consumer culture of the United States. Labor in the capitalist marketplace left less time for traditional subsistence strategies, which were gradually replaced by the ability to purchase food and other necessities. As more and more Hopis began working for cash, their survival became less dependent on their ability to cultivate traditional foods and subsequently on their relationship with the local environment. Opportunities away from home, including boarding schools, technical training, and subsequent employment resulted in many Hopis leaving the reservation in an effort to procure the material trappings of Western society.

By the 1960s, traditional agricultural practices were in decline on the Hopi mesas as more and more Hopis continued to leave the reservation for economic opportunities elsewhere. While some Hopis were able to secure employment at home for the Bureau of Indian Affairs and the

¹⁰⁹ For comparative examples of American Indian experiences with wage labor and the adaptation of indigenous lifeways in shifting economic contexts, see Alexis Celeste Bunten, “More like Ourselves: Indigenous Capitalism through Tourism,” *The American Indian Quarterly* 34, no. 3 (2010): 285–311; Caroline F. Butler and Charles R. Menzies, “Working in the Woods: Tsimshian Resource Workers and the Forest Industry of British Columbia,” *The American Indian Quarterly* 25, no. 3 (2001): 409–30; Brenda J. Child, *My Grandfather’s Knocking Sticks: Ojibwe Family Life and Labor on the Reservation* (St. Paul, MN: Minnesota Historical Society Press, 2014); Brian C. Hosmer, *American Indians in the Marketplace: Persistence and Innovation among the Menominees and Metlakatans, 1870-1920*, Development of Western Resources (Lawrence: University Press of Kansas, 1999); Alice Littlefield and Martha C. Knack, eds., *Native Americans and Wage Labor: Ethnohistorical Perspectives* (Norman: University of Oklahoma Press, 1996); Garth M. Massey, “Making Sense of Work on the Wind River Indian Reservation,” *American Indian Quarterly* 28, no. 3/4 (July 2004): 786–816; Meeks, “The Tohono O’odham, Wage Labor, and Resistant Adaptation, 1900-1930”; Chantal Norrgard, “From Berries to Orchards: Tracing the History of Berrying and Economic Transformation among Lake Superior Ojibwe,” *American Indian Quarterly* 33, no. 1 (January 2009): 33–61; O’Neill, *Working the Navajo Way*.

U.S. Public Health Service building public infrastructure including roads, water and sewer developments, many wage workers sought employment away from home working in industries such as private construction.¹¹⁰

These off-reservation employment opportunities created a labor regime in which many Hopis worked away from home for most or part of the year. Many of these individuals and their families, however, returned each summer to participate in agricultural activities and cultural events. For those who lived away from the mesas, but returned home in the summers to help extended family members, oftentimes grandparents, in their fields and gardens, these experiences were vital in the generational transmission of environmental and agricultural knowledge. Such experiences also demonstrate the resilience of Hopi culture in the face of extreme social and economic upheaval.¹¹¹

Many of those who returned home during the summers in the 1960s were children like a Hopi woman whose parents worked in Chinle, Arizona, where the family lived for the majority of the year. Each summer as a young girl, her family would return home to the reservation. She vividly remembers her time at Wepo Springs, an irrigated farming area near First Mesa that thrived with numerous fields, terrace gardens, and orchards during her childhood. There, amidst luscious plots of purple beans and groves of aspen trees that twinkled each night with the glow of fireflies, her family made its summer home. She and the other children helped to plant and maintain the gardens, irrigate the terraces, and chase away critters like porcupines that would

¹¹⁰ U.S. Department of Commerce, "U.S. Department of Commerce Area Redevelopment Administration ARA Casebook Number 10, October 1964" (U.S. Government Printing Office, Washington, D.C., October 1964), RG 75 Records of the Bureau of Indian Affairs. Office of the Associate Commissioner. Office Files of Associate Commissioner James E. Officer, 1959-67. Box 17. Hopi to Housing. E193A. Folder: "Hopi 1 of 4," National Archives I, 3.

¹¹¹ Hopi woman, interview by author, Kykotsmovi, Arizona, April 26, 2013; Hopi man, interview by author, Flagstaff, Arizona, August 14, 2013.

come at night in search of a bite or two of sweet corn. The experiences she shared as a young girl in the gardens at Wepo would translate into a maintenance and transmission of both ecological and agricultural knowledge to her own children in the decades that followed.¹¹²

While her parents were able to secure employment off the reservation during the 1960s, unemployment rates for Native Americans remained significantly higher than those of non-indigenous Americans during this time. The economic plight of Native Americans on reservations across the United States began gaining the attention of politicians in the early 1960s, beginning with a special task force convened by Secretary of the Interior Stewart Udall in February of 1961. Upon completing its study of federal Indian programs in July of that year, the task force recommended that the federal government initiate a new program aimed at developing the resources of Indian reservations.¹¹³ The following year the Bureau of Indian Affairs began to “unify efforts to eliminate poverty among Indians” through its Economic Development Program.¹¹⁴

The Bureau believed that the “successful development of reservation resources, both human and natural,” depended on “stable tribal government.”¹¹⁵ This was especially true on the Hopi Reservation, where the Tribal Council had been defunct since 1942, but was revived in 1950 for the primary purpose of granting mineral leases to outside corporations. This revival of a bare quorum Hopi Tribal Council occurred directly on the heels of the completion of a feasibility study for the development of coal on Hopi and Navajo lands, a study paid for with money from

¹¹² Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

¹¹³ Congressional Quarterly, “Development to Be Pushed on Indian Reservations,” *Congressional Quarterly*, July 24, 1961.

¹¹⁴ “Indian Affairs 1965: A Progress Report from the Commissioner of Indian Affairs” (United States Department of the Interior, 1966).

¹¹⁵ *Ibid.*

the Navajo-Hopi Rehabilitation Act of 1950. In 1961 the Acting Secretary of the United States Department of the Interior authorized the Hopi Tribal Council to grant mineral leases. The Council promptly exercised its new authority, approving a lease to Fisher Contracting Company for a coal prospecting permit the same year. From 1963 to 1965, the Council approved \$3 million worth of exploration leases to coal, oil, natural gas, and chemical corporations. The proceeds from these leases provided much needed revenue for the Hopi Tribe, enabling them to invest in industrial development aimed at providing employment for Hopis.¹¹⁶

In January 1962 the Hopi Tribal Council established the Hopi Resources and Development Committee in an attempt to convert the Council into an effective, efficient governing body. In the 1960s the committee was comprised of representatives elected by their respective villages, who were charged with executing three tasks specific to all potential economic development projects on the Hopi Reservation. The Committee created feasibility studies for all proposed projects, prepared and developed the projects, and finally presented the projects in “packaged forms” to the Tribal Council for consideration. The ultimate objective of the Hopi Resources and Development Committee was to promulgate economic advancement for the Tribe and to establish a broad and sound economic base. The committee’s work would prove important for the trajectory and texture of economic development on the reservation in the decade that followed.¹¹⁷

On the national front, by 1963, under the guidance of policy recommendations made by President John F. Kennedy’s Task Force on Indian Affairs, the Bureau of Indian Affairs had made at least some progress in its goal of developing both human and natural resource

¹¹⁶ Clemmer, 215.

¹¹⁷ Vernon Masayesva, “Hopi Resources and Development Committee,” *Hopi Action News*, September 16, 1966.

throughout Indian country. That year over 4,000 unemployed Indians “obtained wage work on projects initiated under the Accelerated Public Works Program on nearly 100 reservations in eighteen states. Besides providing employment for a significant number of some of the Nation’s neediest citizens,” the Bureau stated, the projects “made important contributions to reservation life through road improvements, upgraded timber stands, the construction of community centers, and the prevention of soil erosion.”¹¹⁸

The thrust of the Bureau of Indian Affairs to turn the nation’s first peoples into a viable workforce gained further traction as the nation prepared to enter a new war on the domestic front. While the Vietnam raged on, President Lyndon Baines Johnson stood before a joint session of Congress on January 8, 1964 and declared an unconditional war on poverty in America. In this, his first State of the Union address as President, LBJ launched what would be known as the War on Poverty, a war, he said, that the richest nation on earth could not afford to lose. While LBJ would not publicly address Native Americans as a target of this newly declared war until a few years later, the programs that the President and his Congress created and implemented would have impacts on Indian peoples across the country.

When LBJ stood in the Capitol and gave his now-famous declaration of a War on Poverty in 1964, about 4,000 Hopis were living on the reservation and nearly 60% of the population was under the age of twenty.¹¹⁹ Forty percent of those Hopis able to work were unemployed. The

¹¹⁸ Bureau of Indian Affairs, “Progress in Indian Affairs Reported in Fiscal 1963,” 1963, Department of the Interior, 1963-1969: Box 34, Folder 1: Indian Affairs 12/63-6/65, Lyndon Baines Johnson Presidential Library.

¹¹⁹ U.S. Department of Commerce, “U.S. Department of Commerce Area Redevelopment Administration ARA Casebook Number 10, October 1964.”

Hopi Tribe had no significant income and a net worth of only \$3,000.¹²⁰ A federal labor survey conducted in 1964 found that “the Hopi breadwinner may have a trade he follows when the opportunity permits, but most of the opportunities are off the reservation or are highly seasonal. When not working for wages, most Hopis have a farm or ranch, which furnishes some support.”¹²¹ Creating jobs on the reservation would become a focal point of the War on Poverty in Indian Country.

Less than two months after the War on Poverty began, Secretary of the Interior Stewart L. Udall “announced the approval of \$1,000,000 in community and urban development projects on 36 Indian reservations and communities in 12 states under the Accelerated Public Works Program.” The projects would provide employment for Indian peoples, including those residing on the Hopi reservation. A community center project valued at \$35,000 was planned under this initiative, and the construction of the center provided 60 man-months of on-reservation employment for Hopis.¹²²

While some Hopis worked on the construction of the Hopi community center, others found employment constructing new roads on the reservation, such as the \$1,000,000 Toreva-Winslow road, which was a major construction project on the Hopi and Navajo reservations in 1964.¹²³ Hopis also found employment opportunities that year constructing Route 3, which

¹²⁰ U.S. Department of Commerce, “U.S. Department of Commerce Area Redevelopment Administration ARA Casebook Number 10, October 1964,” 4.

¹²¹ *Ibid.*, 36.

¹²² Bureau of Indian Affairs, “Interior Department Announces Approval of \$1,000,000 Accelerated Public Works Program for Indians in 12 States,” March 6, 1964, Department of the Interior, 1963-1969: Box 34, Folder 1: Indian Affairs 12/63-6/65, Lyndon Baines Johnson Presidential Library.

¹²³ Bureau of Indian Affairs, “Indian Bureau Reports Accomplishments in 1964,” January 15, 1965, Department of the Interior, 1963-1969: Box 34, Folder 1: Indian Affairs 12/63-6/65, Lyndon Baines Johnson Presidential Library.

became the main east-west road across the Hopi Reservation and southern part of the Navajo Reservation, spanning 164 miles from Tuba City, Arizona to U.S. Route 666 north of Gallup, New Mexico.¹²⁴ With Hopi labor and federal dollars, these road-building projects accelerated the work of connecting the Hopi mesas to regional and national economic and social structures.

While these and other federal works projects provided temporary, on-reservation employment for individuals throughout Indian Country, it was by no means a permanent solution to the bleak economic situation faced by many on reservations across the United States. In an effort to create more permanent jobs on reservations, the Bureau of Indian Affairs amped up its efforts to bring industrial development to places like the Hopi Reservation through its Indian Industrial Development Program, which was begun in the mid-1950s. In its first decade, the program had brought 76 commercial and industrial enterprises to Indian country. By 1965, 52 were still operating and 20 new plants were either set to begin operating or had already agreed to locate on or near Indian lands.¹²⁵

In an effort to expand this program, in which the Bureau assisted private corporations in all phases of plant relocation and expansion, executives of an unnamed petrochemical company, an electronics company, and several other major corporations reported to the Bureau of Indian Affairs that they would be sponsoring a series of meetings across the United States in 1965 where over 300 industrial executives would “consult with Indian tribal leaders about advantages

¹²⁴ Bureau of Indian Affairs, “Road Contract Awarded for Navajo Routes 1 and 3,” May 27, 1964, Department of the Interior, 1963-1969: Box 34, Folder 1: Indian Affairs 12/63-6/65, Lyndon Baines Johnson Presidential Library.

¹²⁵ “Indian Affairs 1965: A Progress Report from the Commissioner of Indian Affairs.”

available to industries in Indian population areas.”¹²⁶ The leaders would discuss financing, the leasing of Indian land, and potential labor forces.¹²⁷ By August of the same year, 52 industrial plants were located on or near reservations employing about 1,500 Indians manufacturing fish products, electronic components, jewel bearings, ladies’ garments, aluminum culverts, furniture frames, hair styling accessories, and plastic aircraft instrument panels. An additional 11 plants were under or nearing construction. The Bureau estimated that about 3,500 would be employed in 63 plants once the initial construction phases were complete and the plants were fully operating.¹²⁸

On August 12, 1966, in the office of Secretary of the Interior Stewart Udall, the Hopi Tribal Council signed a contract with Western Superior Corporation, a subsidiary of the BVD Co., Inc., to establish a \$1.5 million garment manufacturing plant on the outskirts of the off-reservation border town of Winslow, Arizona. The signing of the contract was the culmination of nearly two years of negotiations among Bureau of Indian Affairs officials, the corporation, the town of Winslow, and the Hopi and Navajo Tribes. The site had initially been offered to the Navajos, who refused the offer. The Hopi Tribe then, “stepped in with their own proposal to

¹²⁶ Bureau of Indian Affairs, “Major Companies to Boost Industrial Development in Indian Country,” May 17, 1965, Department of the Interior, 1963-1969: Box 34, Folder 1: Indian Affairs 12/63-6/65, Lyndon Baines Johnson Presidential Library.

¹²⁷ Ibid.

¹²⁸ John O. Crow, “Progress Report for the BIA: Address by John O. Crow, Deputy Commissioner, Bureau of Indian Affairs, before the Governors’ Interstate Indian Council, Santa Fe, New Mexico, Monday, August 9, 1965,” August 9, 1965, Department of the Interior, 1963-1969: Box 34, Folder 2: Indian Affairs - News 7/65-6/66, Lyndon Baines Johnson Presidential Library.

finance the venture with funds from their oil lease bonus,” which was at that time, “the single largest investment to date made by an Indian tribe with an outside firm.”¹²⁹

The Hopi Industrial Park was to be constructed on a 200-acre tract of land donated to the Hopi Tribe by Jack Ross Enterprises, and would employ up to 800 Hopis.¹³⁰ At the groundbreaking ceremony of the Hopi Industrial Park in Winslow during September of 1967, Hopi Tribal Chairman Logan Koopee spoke to the industrial anxieties of many Hopis present that day:

Today is a crucial turning point in terms of our industrial development, development of our human resources and the better living conditions for our people. Our dreams, our hopes and our aspirations are becoming a reality... This does not mean... we are attempting to destroy our tradition and religion... The development of our Hopi Industrial Park will generate ideas and guidelines for bigger and better things. I want to see my Hopi people share with other Indian citizens the Economic benefit. We are entitled to share in the benefits without necessarily losing our rich Indian cultural heritage... We need not abandon our culture and values in order to make effective use of education and gain employment. We can combine and blend the values of both and lead a fruitful life.¹³¹

The words of Chairman Logan Koopee reflect a process of negotiation that was occurring amongst Hopi people. Incorporation into the capitalist marketplace was a goal of many Hopis, but the ways in which this incorporation would impact tradition and culture remained a primary concern of Hopi leaders. The loss of culture through economic development was not inevitable.

¹²⁹ Office of the Secretary of the Interior, “Hopi Indians Sign Contract with BVD for \$1.5 Million Plant in Winslow, Arizona,” August 12, 1966, Department of the Interior, 1963-1969: Box 34, Folder 3: 7/66-7/67, Lyndon Baines Johnson Presidential Library.

¹³⁰ “Garment Firm, Hopis Agree on Winslow Plant,” *Hopi Action News*, August 19, 1966; “Coordination Committee for BVD Plant Appointed,” *Hopi Action News*, September 23, 1966.

¹³¹ “BVD Groundbreaking Opens Doors to Industries,” *Hopi Action News*, September 29, 1967.

Rather, leaders and other individuals sought to combine the best of both worlds in their attempts to acquire what Koopee referred to as the “economic benefit.” This desire to blend two seemingly disparate worlds is reflective of traditional Hopi teachings which emphasize the importance of taking what is useful from outside cultures and incorporating those teachings or technologies into the Hopi way.

The dedication ceremony of the new BVD plant on September 27, 1968 further demonstrated the objective of synthesizing Hopi culture with modern tribal economic development. Hopi Tribal Chairman Jean Fredericks declared the day a general holiday to enable all Hopis to attend the proceedings. Hopi girls wearing traditional Hopi clothing served as hostesses, leading tours of the plant to ceremonial attendees. The Hopi Indian Band provided music for the dedication, and villagers from Moenkopi performed traditional Hopi social dances. According to Fredericks, the opening of the BVD plant symbolized the end of a long journey on which the Hopi people had been travelling for thousands of years.¹³² It was, in his words, a manifestation of Hopi “dreams and hopes,” and represented, “freedom from ignorance, poverty and fear.”¹³³

Secretary of the Interior Stewart Udall was also present at the dedication ceremony, and spoke to the crowd that had gathered to celebrate. In his speech he recalled the initial signing of the contract two years prior where the Hopi leaders present told him that they “considered this joint economic undertaking a milestone in their history – for it represented the initial step by the

¹³² “Attention! Young Ladies,” *Hopi Action News*, August 16, 1968; “Tribe Goes All Out for BVD Dedication,” *Hopi Action News*, September 26, 1968.

¹³³ “Address, BVD Dedication, September 27, 1968,” *Hopi Action News*, October 11, 1968.

tribe to remold its economy into a modern cast.”¹³⁴ This economic restructuring could not have taken place without the work of the Bureau of Indian Affairs, whose agents were the first to contact the tribe about the corporate project. They offered what Secretary Udall called a “one-stop service to industry,” wherein the Bureau assisted industry in the selection of development sites on Indian lands, negotiations with tribal governing bodies, the securement of private and public capital for the industry, and the recruitment and training of Indians for employment.¹³⁵ And throughout the 1960s, numerous other corporations made attempts to establish industrial operations on the Hopi Reservation with the aid of the Bureau of Indian Affairs and the Hopi Tribal Council. While many of these initiatives failed due largely to economic reasons, it is important to note that the objective of each was to bring wage labor to the Hopi people through the production of goods to be marketed outside the reservation as the following examples demonstrate.

In 1966 the Hopi Resources Committee met with Mr. John Goellnor, a garment-manufacturing representative from the California Girlswear Corporation interested in the construction of a sewing plant on the reservation. The proposed plant would employ 200 Hopis who would initially be paid \$50.00 per week. The sewing machine operators would be eligible to earn up to \$100 per week as they became more skilled in the industry.¹³⁶ Before submitting a formal proposal, California Girlswear Corporation requested a survey of potential laborers to determine a minimum of 350 Hopis interested in procuring employment in the proposed

¹³⁴ Stewart L. Udall, “Excerpts of Remarks by Secretary of the Interior Stewart L. Udall at the Hopi Indian Industrial Plant Dedication, Winslow, Arizona, September 27, 1968,” September 27, 1968, Department of the Interior, 1963-1969: Box 34, Folder 4: Indian Affairs - Addresses 1/68-1/69, Lyndon Baines Johnson Presidential Library.

¹³⁵ Ibid.

¹³⁶ “California Girls’ Wear Corporation Factory,” *Hopi Action News*, August 18, 1966.

industry. The Hopi Resources Committee conducted the survey, revealing that nearly 400 Hopis were willing to provide labor as sewing machine operators.¹³⁷ Whether or not the sewing plant ever opened is unclear, as sources on the subject are limited and news publications fail to mention the proposed development beyond the survey conducted by the Tribe for the corporation. What these sources do reveal, however, is a growing demand from Hopis for wage labor. Individuals were negotiating their roles in a changing economy, and many were exercising historical agency through their search for and procurement of employment.

In 1968 the Micro-Wire Corporation, a three-year prospect for development on the Hopi Reservation, finally reached the negotiation stage during which the Hopi Resources Committee, the Development District of Arizona, and the Bureau of Indian Affairs contemplated the construction of this second Hopi factory in the Industrial Park. The factory would manufacture wires of gold, platinum, silver, and aluminum to be used in the space and electronics industries. In addition to negotiating the construction of the Micro-Wire factory, the Tribe authorized attorney John Boyden to study the feasibility of a leather industry, a space and defense oriented industry, and increasing the size of the building housing the BVD plant by one-half.¹³⁸

Yet outside corporate interest in industrial development on Indian lands was only one part of the wider net of economic and social development cast by President Johnson's War on Poverty. Coordinated through the Office of Economic Opportunity, which was created to administer the programs under the 1964 Economic Opportunity Act, War on Poverty programs helped indigenous communities across the United States acquire unprecedented funding for

¹³⁷ "California Girlswear Corporation Survey Completed," *Hopi Action News*, September 2, 1966.

¹³⁸ "Hopi Micro-Wire Industry Being Planned," *Hopi Action News*, July 5, 1968.

economic development initiatives.¹³⁹ In 1968, through nearly \$100,000 worth of OEO grants, the Hopi Action Program was able to employ nearly 50 Hopi men and women for a limited time for work on grant-funded projects including the completion of six newly constructed community centers as well as the distribution of infant formula and evaporated milk to Hopi children.¹⁴⁰ The following year the Hopi Tribe received \$372,085 in funds through the OEO; the tribe used these funds to employ Hopis in community beautification and development projects, as well as nutrition and health outreach initiatives.¹⁴¹ These opportunities created temporary employment for Hopis as well as the development of community infrastructure, but did not address questions of long-term economic sustainability.

While adults were gaining employment through private corporate development projects, Indian youth across the United States seized what were for many their first opportunities to earn cash for their labor. During the summer of 1965, about 22,000 young Native Americans participated in the Neighborhood Youth Corps where they earned the minimum wage of \$1.25 per hour “as hospital aides, library assistants, school and hospital maintenance and repair helpers, assistants in the record-keeping offices of various public agencies, workers on conservation and land reclamation projects, and helpers in public day-care centers for working mothers.” Program participants were high school students ranging from 14 to 21 years of age who were members of families that fell within the poverty index established by the U.S. Labor Department. In the summer of 1965, 283 Hopi high school students worked on “projects to improve their land and villages. It put more cash into the pockets of Hopi families than many customarily see in a year,

¹³⁹ Hosmer and O’Neill, *Native Pathways*, 93-4.

¹⁴⁰ “Combined Budget of \$108,000.000 Approved by the OEO Indian Division For Special Projects,” *Hopi Action News*, June 28, 1968.

¹⁴¹ “\$372,085 in OEO funds granted tribe,” *Winslow Mail*, July 10, 1969.

as the Hopi economy is still geared to livestock and crop farming, and some crafts production.”¹⁴² Hopi youth worked for various tribal, state, and federal agencies including Plant Management, Land Operations, Law and Order, Roads Department, PHS Hospital, Keams Canyon Boarding School, Oraibi Day School, Hopi Tribal Hall, Hotevilla Day School, Hopitue Trailer Park, Hopi Community Action Program, Arizona State Employment Welfare Office, and Keams Guidance Office.¹⁴³

Like the young men who earned their first paychecks working on federal projects in the 1930s and 1940s, many youngsters in the 1960s and 1970s got their first taste of cash laboring for War on Poverty programs like the Neighborhood Youth Corps. Teenagers, as a Third Mesa farmer recalls, “were hired as laborers in the village because Indian Health Service was coming in and putting in all these water lines, sewer lines, [and] lagoons.” Corps members operated backhoes and front-end loaders and used hydraulic jackhammers to drill through the bedrock, working their “tails off, eight hours a day.”¹⁴⁴ Such experiences provided Hopis with a paycheck as well as an introduction to labor away from the fields and rangelands.

For many Hopis, young and not-so-young alike, working for private industry or on federally funded projects during the 1960s was a transformative experience in terms of labor, culture, and subsistence. While the Tribal Council actively pursued economic development

¹⁴² Bureau of Indian Affairs, “Neighborhood Youth Corps Gives Indian Youngsters a ‘Step Up,’” September 20, 1965, Department of the Interior, 1963-1969: Box 34, Folder 2: Indian Affairs - News 7/65-6/66, Lyndon Baines Johnson Presidential Library.

¹⁴³ Vernon Masayesva, “Hopi Resources and Development Committee,” *Hopi Action News*, September 16, 1966; “Hopi NYC News,” *Hopi Action News*, June 30, 1967; “N.Y.C.,” *Hopi Action News*, July 14, 1967; “Neighborhood Youth Corps Summer Program,” *Winslow Mail*, May 1, 1969; “NYC Program Expanded Here,” *Winslow Mail*, July 26, 1973; “NYC Program Okayed For Hopi Reservation,” *Winslow Mail*, May 24, 1973.

¹⁴⁴ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, June 29, 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona.

projects, the traditional farming economy of the Hopi people wavered. Wage labor became the norm for many families, allowing them to purchase their subsistence rather than farm for it, severing dependence on the local environment for physical survival. Shifts away from traditional subsistence strategies were not unique to the Hopi during this period. For example, by the 1950s at least half the food eaten on the Tohono O’odham Reservation was purchased with wages rather than farmed or gathered.¹⁴⁵

On the Hopi Reservation, a decline in traditional agriculture culminated in the 1960s and 1970s.¹⁴⁶ By 1970 it is estimated that only 3,000 acres of land were under cultivation at Hopi.¹⁴⁷ This figure contrasts sharply with the nearly 7,000 acres reported to have been cultivated in 1952.¹⁴⁸ In less than twenty years, Hopi farms had dwindled to less than half of their former acreage. While cultivation was on the decline, labor statistics were rising. By 1973, 52% of Hopis “available for labor” were employed;¹⁴⁹ this percentage increased to 63% in 1986 and to 71% by 1990.¹⁵⁰

By the mid-1970s few, if any, Hopis continued to practice a pure subsistence economy. Remnants of the old economy still existed, but the relative isolation of the villages had disappeared with the emergence of paved roads, electricity, television, and, most significantly, wage work. These modern realities often left little time for the extensive activities associated

¹⁴⁵ Henry F. Dobyns, *Papagos in the Cotton Fields* (Tucson, Arizona: University of Arizona, Department of Anthropology, 1951), 77.

¹⁴⁶ Vasquez, 83.

¹⁴⁷ Maitland Bradfield, “The Changing Pattern of Hopi Agriculture” *Royal Anthropological Institute Occasional Paper* 30 (1971) : 19, 31.

¹⁴⁸ Bureau of Ethnic Research, *Indians of the Southwest: A Survey of Indian Tribes and Indian Administration in Arizona, 1953* (Tucson: University of Arizona, 1953.), 102.

¹⁴⁹ Hopi Tribe, *Overall Economic Development Program of the Hopi Tribe for the Fiscal Year 1975-1976*, 35.

¹⁵⁰ Clemmer, 276.

with the production and consumption of traditional foods. For example, the preparation, cultivation, and harvest of Hopi fields are a full time occupation from mid-April to October, traditionally performed by men. In order for the harvest to be consumed by the community, Hopi women spent between three and four hours daily grinding corn in order to sustain an extended family of seven to nine members. Given the labor-intensive nature of traditional Hopi agriculture, it is not surprising that many Hopis did not continue their former subsistence activities in the face of capitalist transition.¹⁵¹

Editorial columns appearing in the Hopi newspaper *Qua'toqti* during the 1970s reveal the stark transition from an agrarian society to one engaged in capitalist consumerism. Labor in a factory or tribal administration, in the eyes of some, was easier than tending fields of corn in the harsh Arizona desert. For many who continued to farm, the cultural, social, and ceremonial requirements of being a Hopi drove them to continue their ancestral farming practices. As the words of one *Qua'toqti* columnist writing in 1974 reveal, farming had become “more or less a sideline, required by social custom and tradition.” Exchanging labor for cash “to buy food at the store,” the columnist argued, was “a lot easier than struggling to make the desert produce food.”¹⁵²

The proliferation of wage labor was one of several changes that contributed to a shift away from traditional agricultural practices for many Hopis. Some argue that alcohol and drugs also played important roles in this transformation, as struggles with substance abuse affected the

¹⁵¹ A.F. Whiting to James L. Varner, 17 August 1976, A.F. Whiting Collection, MS No. 25, Box 14, Vol. H67, Cline Library Special Collections, Northern Arizona University, Flagstaff, 209; D.H. Calloway and H.V. Kuhnlein, “Contemporary Hopi Food Intake Patterns,” *Ecology of Food and Nutrition* 6 (1977): 171.

¹⁵² “Land Means Food, Better Than Gold,” *Qua'toqti*, November 14, 1974.

capability of some to continue farming and ranching.¹⁵³ Others emphasize the role played by boarding schools, which affected both the transmission of agricultural knowledge and the availability of young people's labor.¹⁵⁴ And while both of these examples played roles in the shifting nature of agricultural practices on the Hopi Indian Reservation during the 20th century, the growing dependence on cash earned in the marketplace was particularly influential.

The story of the once vibrant seasonal farming community at Wepo Springs exemplifies the ways in which a growing cash economy affected a decline in traditional agriculture there in the 1960s, 1970s, and 1980s. One Hopi woman recalled the changes that started taking place at Wepo Springs in the 1960s. In her memory the economic changes that occurred during the 1960s and 1970s were rapid. As modern conveniences became more available to Hopis as a result of cash earned through wage labor, those who farmed and gardened at Wepo Springs "started abandoning [their farms and gardens] and slowly started moving away." By the early 1970s, fewer and fewer Hopis were farming the area. "People now had jobs," she recalled, and "were now enjoying the benefits of the modern conveniences." These changes required having to "go to work to pay for what they had in their homes," such as electricity and television. "They had to go to work to afford the things they had."¹⁵⁵ Her recollection highlights the ways in which the cash economy contributed to new forms of consumption and increased dependence on capitalism to acquire such goods and services.

¹⁵³ Hopi woman, interview by Tai Johnson, Kykotsmovi, Arizona, August 17, 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona; Hopi man, interview by author, Kykotsmovi, Arizona, April 26, 2013.

¹⁵⁴ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

¹⁵⁵ Louella Nahsonhoya, interview by Kyrie Thompson, 20 October 2005, Collection No. NAU.OH.2005.111.9, Cline Library, Northern Arizona University, Flagstaff, Az.

By the early 1970s there were only three or four farmers planting the terraced gardens of Wepo Springs, and no one was caring for the orchards. The house in which the woman once lived was crumbling, along with the dwellings of the farming community's former inhabitants.¹⁵⁶ The land remained, but the anthropogenic landscape had changed drastically. Things were, as she put it, missing.

There was no longer this place where we could play around the corn; or no longer our jack and the beanstalk beans growing anymore; and no longer the fruit trees; or our favorite spot on the rock where we would sit and make pottery and stuff like that. All these places were just gone. They were missing.¹⁵⁷

The Hopi landscape, once filled with terraced gardens, productive orchards, and cultivated fields, had been unremittingly changed by the economic transformation that blew across the Hopi Mesas in the second half of the twentieth century. This Hopi woman's account of agricultural decline in the village of Wepo Springs highlights the relationship between cash economies, Euro-American technology, and traditional subsistence bases. The environmental isolation of the Hopi villages had, in part, allowed traditional subsistence farming to thrive well into the twentieth century. The introduction of a cash economy through wage labor, access to the "outside world" through improved modes and routes of transportation, and the arrival of so-called modern conveniences that required cash allowed little room for the persistence of traditional subsistence activities.

While the number of dry farmed fields of corn and beans were shrinking alongside irrigated farming terraces like those at Wepo Springs, so too were the herds of sheep that had grazed the Hopi mesas since the arrival of the Spanish hundreds of years earlier. As more and

¹⁵⁶ Ibid.

¹⁵⁷ Ibid.

more Hopi men left the reservation for educational and employment opportunities, the communal labor pool necessary for herding sheep quickly diminished. Many farmers born in the 1950s spent their childhoods helping their fathers, uncles, and grandfathers tend to their flocks, a task that required daily attention as they herded sheep to new grazing areas and water sources. When these young men left home to attend boarding school, to join the military, or to seek employment opportunities off the reservation, the older generation was left without the hands necessary to manage large flocks. Some of these older men had wage labor jobs at home and without the help of their sons and nephews, found it difficult to continue the tradition. When one Hopi man married in 1984, he was the last one of his brothers remaining at home, helping his father herd sheep. When he left home, his father sold the remnants of his flock to Navajo friends near Hard Rock with whom he had traded for years. “When I got married in ’84,” he recalled, “that’s when our father went up there and took the last of the fifteen head.” At that point in time, his father had reduced his flocks significantly, but those remaining were some of the descendants of the “original sheep that our grandfather had given to our father back from the thirties and forties.” The herd had lasted, he stated, “a good fifty years before we exited the program.”¹⁵⁸

For other families, the sheep herding tradition ended when the last father, uncle, or grandfather maintaining the flock became ill, as was the case with one Hopi man whose father who suffered a stroke in the early 1980s. This shifted the burden of maintaining the family’s flock to the son, who “literally quit work” and “became pretty much a full time shepherd” for the next year. His father did not recover from the stroke and so, “he chose to just end his sheep

¹⁵⁸ Hopi man, interview by author, June 10, 2013. Hotevilla, Arizona. Hopi Cultural Preservation Office Archives. Kykotsmovi, Arizona.

herding days, which I was doing for him.”¹⁵⁹ By the late 1990s only one herd of sheep remained on the Hopi mesas, owned by a man who tended his flock daily on foot well into his eighties. As he aged, the man could no longer handle the daily needs of his flock and so, in the earliest years of the twenty-first century, the last flock of Hopi sheep disappeared along with the sheep herding culture that had persisted for nearly 500 years.¹⁶⁰

Yet the death of sheep culture on the Hopi mesas did not signify an end to animal husbandry. One man recalled his grandfather who played a major role in the Bureau of Indian Affairs livestock improvement programs of the 1940s, “he turned sheep into cattle.”¹⁶¹ The transition from sheep to cattle that began in the 1940s with folks like this man’s grandfather continued throughout the second half of the twentieth century. Driven by economic forces and shifting labor regimes, many Hopis did, indeed, turn their sheep into cattle throughout the second half of the twentieth century. Cattle brought a higher market price than their woolen counterparts, and required far less labor. For a different man’s father, who turned his sheep into cattle in the 1970s, the motivation was labor-driven. His father turned to cattle, “because you don’t need to herd cattle. They’ll take care of themselves.”¹⁶²

While sheep numbers dwindled alongside the number of productive, full time farmers on the Hopi reservation, many were dismayed by the changes taking place. The resistance of many individuals to new lifeways is evidenced by their reactions to those who did not continue traditional subsistence activities. As early as the 1970s, Hopis began to question the choices many of their friends and family had made when stepping into the world of wage labor. Opinion

¹⁵⁹ Hopi man, interview with author, June 5, 2013. Kykotsmovi, Arizona. Hopi Cultural Preservation Office Archives. Kykotsmovi, Arizona.

¹⁶⁰ Ibid.

¹⁶¹ Tewa man, interview by author, November 8, 2013. Tewa Village, Arizona.

¹⁶² Hopi man, interview by author, Kykotsmovi, Arizona, August 6, 2013.

columns appearing in *Qua'toqti* illuminate the desire to maintain a traditional subsistence base and resistance to the new economic world that was evolving on the mesas. As the author of a column appearing in 1973 stated:

It is true that since we live in a world which requires dollars to live in it, we have to make money, but let us not do it at the expense of our fields and farms. Farms and fields are what provide security, not dollars. Once there were beautiful orchards and gardens all around us. We abandoned them when we went to work for dollars. We may be forgiven for our human weaknesses but our Mother Earth may not forgive us for neglecting her again.¹⁶³

Indeed, many Hopis chose not to neglect their farming traditions in the face of wage labor, but instead found new ways to adapt the ancestral institution to a changing way of life as they had done for centuries. The ability of many Hopis to maintain farming practices in the face of economic transition rested in part on growing opportunities for wage labor on the Hopi reservation itself, predominately through employment with the Hopi Tribe.

Royalties from the coal leased by the Hopi and Navajo Tribes to Peabody Coal from the Black Mesa mine began flowing into tribal coffers by the late 1960s, supporting the core functions of the Tribal Government. As the mining operation began to expand, coal royalties began to dominate the revenue of the Tribe, enabling expansion of operations and hence jobs available to Hopis at home. By the early 1980s coal royalties averaged nearly \$18 million per year, constituting 80% of tribal revenue.¹⁶⁴ By 1986, 45% of jobs on the Hopi Reservation existed in the expanding Tribal Government, with 470 Hopis employed. Government agencies such as the Bureau of Indian Affairs, which provided 25% of employment opportunities, and the

¹⁶³ "Can Hopis Find a Way Back to Nature?," *Qua'toqti*, September 20, 1973.

¹⁶⁴ Hopi man, interview by author, Kykotsmovi, Arizona, June 29, 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona.

Indian Health Service, which accounted for 10% of jobs on the reservation, also served as major consumers of Hopi labor.¹⁶⁵

By this time, Hopi farming did not disappear as many had predicted twenty-five years earlier. While forty hours per week in a factory or office cubicle made full time farming nearly impossible, many continued to farm by adapting their traditional practices to changing economic and technological structures. At the core of this process of adaptation was a single piece of Western farming technology that would change not only the way Hopis farmed, but the size and structure of their fields as well, enabling wage laboring Hopis to continue their agricultural traditions as what Stewart Koyiyumptewa calls “weekend farmers.”¹⁶⁶

Nearly all of the individuals I interviewed had the same initial response when asked how farming had changed within their lifetimes. Men and women, farmers, gardeners, and ranchers all responded with stories of how Hopis now utilize the tractor to prepare, plant, and weed their fields. While attempts by the Bureau of Indian Affairs and Soil Conservation Service to introduce the tractor and mechanized farming methods to Hopi farmers in the 1930s and 1940s ultimately failed, the economic transition to a predominately cash economy dependent on wage labor facilitated the widespread adoption of tractor technology during the last quarter of the twentieth century. For many Hopis who work forty hours per week outside the fields, and have little help from extended family for agricultural work, the use of a tractor to successfully cultivate their fields is a necessity.

Before Hopis were fully engaged in a wage labor economy, they cooperated with one another to cultivate the crops that formed the basis of their economy. Planting parties, where

¹⁶⁵ Clemmer, 20.

¹⁶⁶ Hopi man, interview by Tai Johnson, 6 July 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona.

families, clans, and even entire villages, would work together to plant a farmer's field were critical to the overall success of agricultural production. In many villages, as late as the 1950s, community cooperation was the driving force behind Hopi farming, which stands in contrast to contemporary accounts from the same community some fifty-odd years later. In the past, a farmer exchanged labor in one man's field for labor in his own. Now, some expect monetary compensation for their labor.¹⁶⁷

Rather than engaging in traditional planting parties, farmers turned to tractors and even mechanical planters to ensure they would have enough time to prepare, plant, and harvest their fields. When asked how farming had changed since his childhood in the 1940s and 1950s, a First Mesa farmer immediately responded with a discussion of the proliferation of tractors and mechanical planters, and how these new technologies differed from older forms of communal labor. "Long ago they used planting sticks," he explained, "and the person who is going to plant announced a planting party." The following day the men from the village would gather to go plant while the women cooked to feed the men when they returned. "That's how it used to be," he remembered. "They don't ask for money, they don't get money." Now some expect cash payment for helping others plant. "So now," he stated, "all this has changed."¹⁶⁸ The last planting party this farmer witnessed in his village occurred in the 1950s. Across the Hopi mesas farmers today often recall the days in which communal farming efforts served as forces to unite a village for both physical and spiritual subsistence. Some communities still hold planting parties, but

¹⁶⁷ Hopi man, interview by Tai Johnson, First Mesa, Arizona, August 3, 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona.

¹⁶⁸ Hopi man, interview by Tai Johnson, First Mesa, Arizona, August 3, 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona.

others, such as Hotevilla, have not done so since the 1980s.¹⁶⁹ This has increased the time and labor burden of individual farmers. The tractor has enabled Hopi farmers in the late twentieth and early twenty-first centuries to cultivate more area and to maintain better weed control during the growing season, labor that was formerly engaged in communally.¹⁷⁰

The number of Hopis engaging the help of the tractor in contemporary farming practices can be directly linked to increased numbers of farmers who also hold down full time jobs. According to a Second Mesa farmer who is also an employee of the Tribe, the number of farmers using tractors has increased significantly since the 1950s. When he was younger, he recalled that only a few farmers had tractors. His family, as well as most others, cleared and planted their fields by hand. “Then sometime along the way my dad would hire this guy to clear our field [by tractor],” he remembered. “But that wasn’t all the time. I bought myself a tractor in ’87.” Since then, the use of tractors to clear, maintain, and plant fields has proliferated. Most clear their fields with tractors today. Some still plant by hand, “but there’s quite a few that plant by tractor also,” the farmer stated.¹⁷¹

The use of the tractor by Hopi farmers has affected not only the labor required to plant and maintain a field, but has also contributed to an increase in the size of Hopi fields, as one Hopi farmer recalled in the summer of 2013.

The fields are expanding, too, I think. They’re no longer simple one-acre, two acre plots. They can be as big as maybe twenty acres. And you can see it coming from Moenkopi, Tuba City area when you come off Howell Mesa. You can see the landscape of Dinnebito. There’s just a whole wide variety of, and all over the

¹⁶⁹ Koyiyumptewa, interview.

¹⁷⁰ Kuwanwisiwma, interview.

¹⁷¹ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, August 17 2007, Hopi man, interview by Tai Johnson, First Mesa, Arizona, August 3, 2007, Hopi Cultural Preservation Archives, Kykotsmovi, Arizona.

valley there, plowed up fields...sand, soil. And so I think that's changed over time. I think it's because more and more families have purchased tractors to do that, to expand their fields and try to get a greater yield from all their work in that particular year.¹⁷²

While some farmers are concerned about the increased size of Hopi fields, others discuss the potential impacts that tractors might have on Hopi soil when considered alongside the increasingly violent winds plaguing the Hopi mesas in the spring and early summer. One Hopi woman sees these issues as intricately related to one another.

I hear a lot of talk about the impact that's having on loss of topsoil with the winds that come into play in the springtime or anytime around here. That's probably the biggest change. And maybe even...the fields being larger. I really don't know how big a field was a hundred years ago, but I know they had to be manageable. I hear of farmers talking about the expansive fields and about whether that's a good or bad thing. And I think tractors allow you to expand it and do more than you would if you were just doing it by hand.¹⁷³

Another male farmer also sees potential problems with soil erosion. Smaller, less open farms often mean less wind damage for farmers, he explained to me. "But with a tractor people open up bigger fields so the wind comes through and takes up a lot of their topsoil," he stated. The use of tractors has also led to the proliferation of invasive species. "A lot of people hire other people to do their fields," he told me. But if the tractor-operator doesn't wash down his tractor as he moves from one field to the next, the seeds of invasive species like Russian thistle and silver leaf nightshade by tractors hired to work multiple fields for different farmers. "That's how it's getting spread around," he explained.¹⁷⁴

¹⁷² Hopi man, interview by author, July 31 2013.

¹⁷³ Hopi woman, interview by author, Kykotsmovi, Arizona, July 31 2013.

¹⁷⁴ Hopi man, interview by Tai Johnson, July 6, 2007, Kykotsmovi, Arizona. Hopi Cultural Preservation Office Archives. Kykotsmovi, Arizona.

Despite the potential environmental problems arising from the use of the tractor, its necessity for many farmers is indeed critical to their overall success in maintaining farming traditions. The cultural obligations surrounding the cultivation of corn for both social and ceremonial events led many Hopi farmers to adapt their farming technology to a new economic reality. “Weekend farmers” began adapting to the dual worlds of wage labor and traditional farming as early as the 1970s, and the continuation of Hopi farming can be attributed to their ingenuity, agricultural expertise, and openness to new agricultural methods – all of which have been characteristics of Hopi farmers for over one thousand years. One Hopi man’s recollection of his grandfather’s early adoption of the tractor speaks to these issues.

Early on he didn’t use a tractor, but as he was able to save up money for a tractor, he began to use a tractor. Not only because there was nobody to help him, but it’s just a lot faster. And he was employed with the Forest Service, so the only time he had time to go out to the field was during the weekends when he came home. So I think that was one of the reasons why he began using the tractor because he was stationed in Happy Jack for the week and then he would come home and then tend to his fields and either leave early on Monday or late Sunday back to Happy Jack. I think that was one of the major reasons why he decided to go with a tractor, just because it saves up a lot of time, you know. Instead of hoeing with your hand, you can do a lot more with a tractor than doing stuff manually.¹⁷⁵

While many Hopis were adapting farming strategies to align with their lives as wage laborers through the utilization of the tractor, some were also finding more efficient ways to actually plant their fields. The introduction of the mechanical planter is a recent adaptation to the continually evolving institution of Hopi farming, enabling farmers lacking the communal manpower of decades past to continue living as Hopi farmers. Some have traded in their

¹⁷⁵ Hopi man, interview by Tai Johnson, July 6, 2007, Kykotsmovi, Arizona. Hopi Cultural Preservation Office Archives. Kykotsmovi, Arizona.

traditional planting stick for a mechanical planter that attaches to the tractor, saving precious time in the planting of their fields. This technological adaptation had made its way into the farming repertoire of many Hopis as early as the late 1970s. The following observation from 1979 accurately describes the technological adaptations utilized by some farmers during this time. It also demonstrates both the adaptability of Hopi farmers as well as their enthusiasm for new agricultural technologies that align with shifting economic conditions and labor pools.

Several years ago, we observed tractors replaced the hoe, but we still planted by hand, so that was all right. Recently, we discovered a still more unusual thing out in the cornfields. Two men were riding and driving a strange machine. It had large rear wheels with a metal box attached, from which, through a pipe, kernels of corn dropped into a furrow made by the machine, each time the wheel made one revolution. It was a planting machine, which did the work of a full crew of planters, two days' work in about two hours.... When other Hopis learned about the machine, there formed long lines of farmers waiting to have the machine plant their fields.¹⁷⁶

By the beginning of the twenty-first century, nearly seventy percent of Hopi farmers were using a tractor to aid them in their agricultural pursuits. A survey conducted among 77 Hopi farmers in 2003 by the Hopi Pu'tavi Project found that eighty percent of farmers under the age of 55 were using a tractor, compared to sixty-two percent of farmers 55 and older. The study demonstrates the pervasiveness of this technological adaptation and the reality that farming with a tractor is now the Hopi way for many.¹⁷⁷ This technological change has facilitated the maintenance of traditional farming practices on the Hopi mesas. Like “turning sheep into cattle,” tractors and mechanical planters have become new traditions, situated within an ancestral culture

¹⁷⁶ “The Unchanging Hopi Way,” *Qua'toqti*, July 19, 1979.

¹⁷⁷ Hopi Farmer Survey Results.

that still strives to care for its homeland as Máasaw instructed them to do when they entered this world.

The survival of Hopi agriculture into the twenty-first century is directly related to changes in technology that have allowed many Hopi men to meld their identities as farmers, ranchers, and wage laborers. The acceptance and incorporation of outside technology – like the tractor - into the institution of Hopi farming stands testament to cultural survival in the face of economic transformation. While some Hopis look at these adaptations as detrimental to the very nature of traditional Hopi farming, others see them as a means of (agri)cultural continuity in a constantly changing world.

The evolution of both indigenous and non-indigenous institutions through the process of economic transformation that characterized Hopi history in the twentieth century directly impacted the culture of farming on the Hopi mesas. The expansion of the Tribal Government, a direct result of income from mineral leases, can be viewed as both detrimental and beneficial to the institution of farming. On one hand, the expansion of employment opportunities with the tribe redirected labor from the fields to office cubicles. On the other hand, these employment opportunities allowed Hopis to participate in a cash economy without having to leave the reservation, empowering many to continue their roles as farmers, albeit in adapted versions.

Over the course of the twentieth century, cash found its way into the pockets of Hopi men and women in a variety of ways. Earnings from local tourism, the sale of arts and crafts, and livestock were used early on to supplement traditional subsistence practices. While these sources of income continue to support many Hopi families to this day, it was the evolution of Hopi wage labor that most significantly impacted the institution of Hopi agriculture as more and more Hopis found their labor being redirected from their fields and terraced gardens to the marketplace. As

wage labor both on and off the reservation became a reality for many Hopis, the time they had to dedicate to farming rapidly diminished.

As Hopi labor resources were redirected from the farm to the marketplace, traditional agricultural practices declined significantly. Many Hopi farmers and gardeners, however, did not abandon their ancestral practices, but rather adapted their time and techniques to a new economic reality. For some, this meant leaving their fields, traveling long distances for wage labor opportunities, and returning home seasonally to help their families with agricultural activities and participate in cultural events.¹⁷⁸ For others, especially those who were able to secure wage labor jobs on the reservation, adaptation took a technological turn as farmers slowly began mechanizing their fields through the adoption and utilization of tractors and mechanical planting implements.¹⁷⁹ While this technological adaptation, a direct result of the shift from a primarily agrarian economy to one dependent on cash, enabled many Hopis to continue farming, it also helped facilitate a number of environmental changes including increased field sizes, soil erosion, and the spread of noxious weeds.

The economic transformation of Hopi culture undoubtedly changed the nature of survival on Black Mesa. Farming has persisted through cultural adaptation, but the institution no longer forms the basis of Hopi subsistence. Life on the mesas is no longer primarily fed with M^áasaw's planting stick, pouch of seeds, and gourd of water, or with Hopi sheep. This decline in agriculture affected biological resources like the Hopi plants and animals that once formed the basis of the Hopi diet.

¹⁷⁸ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

¹⁷⁹ Hopi man, interview by author, Kykotsmovi, Arizona, June 5, 2013; Hopi man, interview by author, Kykotsmovi, Arizona, July 31, 2013.

CHAPTER TWO FOOD, HEALTH, AND AGROBIODIVERSITY

In the summer of 1934 a young Hopi woman named Irene waited in the kitchen of her Second Mesa home for the arrival of Pearl Beaglehole, an anthropologist whom she had befriended in the summer of 1932. Pearl and her husband Ernest had returned to the Hopi Mesas that summer to continue the fieldwork they began two years prior, interviewing Hopi men and women on topics ranging from agriculture and hunting to dreams and sorcery. Irene and her mother's brother, Yusi'ima, had agreed to meet with Pearl and share their knowledge of Hopi foods and culinary practices.

Irene and Yusi'ima lived in the Second Mesa village of Shipaulovi, and both possessed an intimate knowledge of Hopi foods and the environment in which they were cultivated and gathered. One of the oldest living men on the Hopi mesas, Yusi'ima had a deep understanding of the plant world from which Hopis had drawn their subsistence for generations. The Hopi world in which Yusi'ima grew up was one where both physical and cultural survival depended on the successful cultivation of locally adapted crops, sustainable access to natural resources like wild foods and clean water, and an intimate knowledge of the plants, animals, land, and water that had supported life on these mesas for over a thousand years. As a small child he survived what Hopis called the Great Famine, a drought that plagued the Hopi villages from 1862-1863. In the summer of 1934 he was one of only four survivors of the Great Famine still alive to tell the stories of the rain that never came, corn that failed to grow, and sickness that overtook his people. Yusi'ima's childhood experience of extreme scarcity undoubtedly shaped his understanding of how ecological circumstance conditions culinary practice and ultimately human survival. When the rains failed to reach the roots of corn planted deep in the sand, his mother,

grandmothers, and aunts had traveled beyond their fields and gardens to collect plants that had always contributed to their subsistence, especially in times of drought. And when these food sources failed to nourish their families, the women had traveled east with their husbands and children to wait out the famine.¹⁸⁰

As he spoke with Pearl Beaglehole that summer afternoon, Yusi'ima expressed deep regret and sadness for the changes he had witnessed over the course of his lifetime. He told the anthropologist that while most of the traditional corn dishes he had grown up eating remained a part of the Hopi diet, those that included wild foods once gathered by the women in his family had all but disappeared.¹⁸¹ The absence of these wild foods in Yusi'ima's diet elicited a profound sense of loss and sadness in the elderly man, one that echoed in the voices of Hopis I interviewed nearly eighty years later. In the 1930s, men like Yusi'ima faced changes in the food system that nourished their bodies and souls. An ecological decline in biodiversity, combined with drought stress, reduced the availability and use of wild foods. Culinary diversity shifted away from dishes dependent on the collection and management of these species. As the decades passed, many of the traditional corn dishes that the elderly Hopi found joy in consuming began appearing less and less in Hopi bowls as more and more food from the outside world made its way into the Hopi diet. By the end of the 20th century, traditional Hopi food comprised a minute portion of the average Hopi's sustenance with the majority consumed at cultural events rather than as part of a regular diet.

¹⁸⁰ Pearl Beaglehole and Ernest Beaglehole, "Foods and Their Preparation," in *Notes on Hopi Economic Life*, Yale University Publications in Anthropology 15 (New Haven: Yale University Press, 1937), 70–71.

¹⁸¹ *Ibid.*, 60.

The socioeconomic, ecological, and cultural changes that erupted on the Hopi mesas during the 20th century facilitated the shift from a diet comprised primarily of traditional Hopi foods to one consisting primarily of Western foods purchased at local trading posts and regional grocery stores in border towns like Flagstaff or Winslow. Access to cash earned through wage labor enabled Hopi men and women to purchase food as well as seeds from catalogs and plants from nurseries and big box stores. Such purchases altered daily menus as well as the genetic makeup of fields and gardens. Even those with limited cash gained access to both new plant resources and food products through the policies and programs of government agencies, religious groups, and non-profit organizations as the interviews and archival documents examined in this chapter will demonstrate.

These changes shifted Hopi dependence from an ancestral food system to purchased or acquired non-Hopi foods. While some Hopis were purchasing items like sugar and flour to supplement traditional foodstuffs as early as the late nineteenth century, the dietary transition picked up speed during and after World War II and continued to do so throughout the rest of the century as more and more Hopis gained access to non-Hopi foods through cash and food aid programs. The availability of agricultural labor decreased as wage labor opportunities proliferated both on and off the reservation as discussed in the first chapter of this dissertation.

The shift away from Hopi foods and increased consumption of Western foods correlated to rising rates of diabetes and obesity among the Hopi people, as Hopis interviewed over the course of my research indicated through sharing personal and community health experiences. By the early 1990s, at least twenty percent of Hopis were battling diabetes, a disease that was

virtually unknown on the Hopi reservation before World War II.¹⁸² The Hopi perspective that locates the supplanting of the traditional Hopi diet with the Western diet as a root of the diabetes epidemic is shared by other indigenous groups, native and non-native scholars, and federal researchers.¹⁸³ The diabetes epidemic that is now a significant contributor to mortality and morbidity in all American Indian populations took root during the second half of the twentieth century, and according to the National Institutes of Health (NIH), “the incidence and prevalence of the disease have increased dramatically as traditional lifestyles have been abandoned in favor of westernization.”¹⁸⁴ Between 1994 and 2009, the prevalence rates of diagnosed diabetes skyrocketed across Indian Country, increasing by 110% in teens 15-19 years old, and by 161% in young adults between the ages of 25-34 years old.¹⁸⁵

¹⁸² Barrett P. Brenton, “Hopi Foodways: Biocultural Perspectives on Change and Contradiction” (Ph.D. Dissertation, University of Massachusetts Amherst, 1994), 153.

¹⁸³ Winona LaDuke, *Recovering the Sacred: The Power of Naming and Claiming* (Cambridge, MA: South End Press, 2005), 191–210; Mariana K. Leal Ferreira and Gretchen Chesley Lang, eds., *Indigenous Peoples and Diabetes: Community Empowerment and Wellness*, Carolina Academic Press Medical Anthropology Series (Durham, N.C: Carolina Academic Press, 2006); James W. Justice, “Twenty Years of Diabetes on the Warm Springs Indian Reservation, Oregon,” *American Indian Culture and Research Journal* 13, no. 3 (1989): 49–81; Gary Paul Nabhan, *Why Some Like It Hot: Food, Genes, and Cultural Diversity* (Washington, D.C.: Island Press, 2006), 166–168; Jennie R. Roe and Robert S. Young, “Introduction: Diabetes Programs and the Need for Cultural Capital,” *American Indian Culture and Research Journal* 38, no. 1 (2014): 11–28; Dawn Satterfield et al., “A Stream Is Always Giving Life: Communities Reclaim Native Science and Traditional Ways to Prevent Diabetes and Promote Health,” *American Indian Culture and Research Journal* 38, no. 1 (2014): 157–90; Carolyn Smith-Morris, *Diabetes among the Pima: Stories of Survival* (Tucson: University of Arizona Press, 2008).

¹⁸⁴ National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases (U.S.), and National Diabetes Data Group (U.S.), eds., *Diabetes in America*, NIH Publication no. 95-1468 (Bethesda, Md.: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 1995), 683.

¹⁸⁵ “Special Diabetes Program for Indians - Overview - Fact_Sheet_SDPI_508c.pdf,” accessed February 2, 2016, http://www.ihs.gov/MedicalPrograms/Diabetes/HomeDocs/Resources/FactSheets/Fact_Sheet_SDPI_508c.pdf.

By 2012, 16.1% of American Indian and Alaska Native adults over the age of twenty were diabetic, compared to 9.3% of the U.S. population.¹⁸⁶ In some American Indian and Alaska Native communities, diabetes prevalence runs as high as 60%.¹⁸⁷ On the Hopi Indian Reservation, by the late 2000s, health officials estimated that at least 40% of patients treated at the Hopi Health Care Center were diagnosed with diabetes.¹⁸⁸ This prevalence constitutes a public health crisis for Hopis, as complications from diabetes including kidney failure, heart disease, and stroke are at least twice as high for American Indians as the general U.S. population.¹⁸⁹

While traditional Hopi lifestyles have not been “abandoned” as the NIH suggests, they have changed dramatically since the 1930s and dietary shifts played a key role in such transformations. These changes left Hopis particularly vulnerable to diabetes and obesity. Gary Paul Nabhan identifies four factors that contribute to the vulnerability of indigenous peoples to metabolic disease – the abandonment of wild foods, changes in agrobiodiversity, the introduction of refined carbohydrates, and the addition of food additives to native diet.¹⁹⁰ Each of these factors played a role in the larger historical process of dietary transition among the Hopi people. The examination of these historical factors illuminates the ways in which transformations in

¹⁸⁶ “National Diabetes Statistics Report, 2014 - National-Diabetes-Report-Web.pdf,” accessed February 2, 2016, <http://www.cdc.gov/diabetes/pubs/statsreport14/national-diabetes-report-web.pdf>.

¹⁸⁷ “Special Diabetes Program for Indians - Overview - Fact_Sheet_SDPI_508c.pdf.”

¹⁸⁸ Jamie Keith, Health Promotion and Disease Prevention: Hopi Health Care Center, telephone conversation with author, September 10, 2007.

¹⁸⁹ “Diabetes in American Indians and Alaska Natives Facts-At-A-Glance - Fact_sheet_AIAN_508c.pdf,” accessed February 1, 2016, http://www.ihs.gov/MedicalPrograms/Diabetes/HomeDocs/Resources/FactSheets/Fact_sheet_AI AN_508c.pdf.

¹⁹⁰ Nabhan, *Why Some Like It Hot*, 179-80.

traditional diets affect public health and how the two are linked to broader shifts in shifts in natural and cultural resources including labor, knowledge, plants, animals, and water.

Information about historical changes in the Hopi diet comes from two distinct sets of sources – interviews I conducted with Hopi men and women, and the published research archaeologists, anthropologists and ethnographers conducted on the Hopi mesas from the late 19th century through the last decade of the 20th century. These sources are, by nature, fragmentary and at best produce tiny snapshots in time of Hopi food, health, and agrobiodiversity. Examined collectively they provide a clearer picture of the larger historical forces at play and how such changes affected Hopi society on both individual and collective levels.

While purchases, policies, and programs altered the diversity of plants and animals cared for and consumed by Hopis, cultural resilience and adaptation ensured that an ancestral food system with one of the highest rates of biodiversity on the continent would survive despite the challenges wrought by globalization. Sustainability of this food system was, and is, not solely dependent on access to soil, seeds, and water, but is structured by culture and by local systems of ecological, agricultural, and culinary knowledge passed from one generation to the next. Both the maintenance and erosion of resources and knowledge worked together over the course of the 20th century to reshape the Hopi food system and revolutionize the Hopi diet.¹⁹¹

¹⁹¹ While many plant varieties and culinary practices survived socioeconomic disruption, fewer and fewer Hopis are maintaining specific plants and practices. When coupled with diabetes and obesity rates that rank among the highest in the United States, maintaining and increasing the cultivation of traditional Hopi foods is critical. The long-term sustainability of this food system hinges on the generational transmission of knowledge and practice as well as the protection of Hopi plant resources from outside contamination, challenges that are being addressed by both the Hopi Tribe and local nonprofit organizations like the Natwani Coalition.

For over one thousand years geographic isolation, environmental adaptation, and cultural resilience shaped the Hopi food system into an eco-culinary world rich in biodiversity.¹⁹² The majority of food prepared by Hopi women was hunted, gathered, and cultivated on ancestral Hopi lands. Hopi men dedicated their lives to dry farming corn, beans, and squash while Hopi women cultivated a diverse array of vegetables and herbs in irrigated terrace gardens. In addition to the agricultural products harvested from these fields and gardens, Hopi men and women hunted animals and gathered plants as far away as the San Francisco Peaks in what is now Flagstaff, Arizona. Anthropologists estimate that historically these non-cultivated foods comprised about 10% of the Hopi diet, perhaps more.¹⁹³ When crops failed, these wild foods played an even bigger role in Hopi survival.

The antiquity, diversity, and resilience of this diet are colorfully detailed in Hopi oral traditions as well as archaeological investigations throughout the Four Corners region of the Southwestern United States. In the late 1970s, archaeologists from the Museum of Northern Arizona analyzed over 60,000 plant remains as part of a project to excavate and restore the Hopi village of Walpi. What the researchers unearthed was a food system deeply rooted in nature and culture. The scientists concluded that over the past 300 years, the people of Walpi had maintained multiple varieties of corn, squash, and beans – varieties that can be traced to ancestral Hopi dwellings throughout the Four Corners region dating back at least one thousand years. This high degree of consistency in selecting and maintaining specific plants and varieties for food use

¹⁹² For published accounts of agrobiodiversity on the Hopi Indian Reservation during the 20th century, see Gary Nabhan, *Where Our Food Comes from: Retracing Nikolay Vavilov's Quest to End Famine* (Washington, DC: Island Press/Shearwater Books, 2009); Whiting, *Ethnobotany of the Hopi*.

¹⁹³ Rushforth and Upham, *A Hopi Social History*, 38.

impressed archaeologists, demonstrating that a large portion of the Hopi diet had not been dramatically altered for a millennium.¹⁹⁴

In addition to ancestral varieties of corn, beans, and squash, archaeologists excavating in Walpi uncovered evidence of widespread cultivation and consumption of crops introduced to Hopi farmers and gardeners as early as the 16th century.¹⁹⁵ The Spanish introduction of melons, onions, peaches, cilantro, apricots, burros, sheep, horses, and cattle was the first and most significant change in the Hopi agricultural system. Scholars credit the Spanish with introducing the Hopi to the chile and tomato.¹⁹⁶

When government officials and anthropologists like Pearl Beaglehole visited the Hopi mesas in the 1930s, nearly 6,000 acres of land were still under cultivation. Over two-thirds of the food Hopi women prepared for their families was grown on tribal lands. Hopi men were dry farming 25 varieties of corn, 23 varieties of beans, at least 7 types of melons, 3 varieties of squash, and multiple types of gourds. In irrigated terrace gardens, Hopi women were tending to at least 18 different cultivars including amaranth, sunflowers, safflower, nanakopsi, cilantro, numerous vegetables, and a multitude of perhaps the most important irrigated crop in the Hopi diet – chilies.¹⁹⁷ While a small number of Hopis earned cash through limited wage labor opportunities, and others became engaged in cash economies through the small-scale sale of livestock, livestock products such as wool, forest products, crops, and arts and crafts to local traders and tourists visiting the reservation. Despite this engagement, overall cash income for Hopis remained low, with per capita income averaging less than \$150 in 1936, a fraction of the

¹⁹⁴ Bob Gasser, “Old Plants at Walpi Talk,” *Qua'toqti*, January 31, 1980.

¹⁹⁵ Ibid.

¹⁹⁶ Whiting, *Ethnobotany of the Hopi*, 9.

¹⁹⁷ Whiting, *Ethnobotany of the Hopi*.

national average for the same year. 40% of Hopi income that year was earned from wage labor, 12% from livestock sales, and 3% from the sale of items including baskets, plaques, and pinions.¹⁹⁸ This limited cash income meant that for the majority of Hopi families, traditional agricultural and culinary practices remained at the center of their livelihoods – and plates.

Nearly 80 cultivars were making their way from fields and terraces into Hopi kitchens to nourish Hopi bodies in the 1930s, contributing to both cultural and biological diversity in an ancestral food system. Like the cultural system that has sustained them for over a millennium, these crops were (and are) uniquely adapted to the ecological and hydrological conditions of a harsh, often unforgiving environment characterized by a limited growing season of 120-160 days, scorching summer temperatures, fierce winds, limited water resources, and high rates of evapotranspiration.¹⁹⁹ These plants have in turn been carefully selected by Hopi farmers over the years to create a diverse crop repertoire capable of producing abundance in a land of scarcity.

In the early 20th century these adaptations captured the attention of G.N. Collins, a botanist working for the U.S. Department of Agriculture. In 1913 Collins traveled to the First Mesa village of Polacca to study Hopi corn. There he found corn planted ten inches deep to the place where the seed was encapsulated in the moist subsoil beneath the sandy surface. From this point a large seminal root reached another thirteen inches through the moist subsoil, providing the plant with moisture during a critical stage of development.²⁰⁰ This adaptation, selected and maintained by multiple generations of Hopi farmers, allows Hopi corn to thrive in an

¹⁹⁸ Section of Conservation Economics, Navajo Area, Region 8, Soil Conservation Service, “Statistical Summary: Human Dependency Survey, Navajo and Hopi Reservations,” May 1939.

¹⁹⁹ Daniela Soleri and David A. Cleveland, “Hopi Crop Diversity and Change,” *Journal of Ethnobiology* 13, no. 2 (Winter 1993): 210.

²⁰⁰ G.N. Collins, “A Drought-Resisting Adaptation in Seedlings of Hopi Maize,” *Journal of Agricultural Research* 1, no. 4 (January 10, 1914): 299–301.

environment where conventional varieties often fail and illustrates how the symbiotic relationship between Hopi farmers and the plants they cultivate contributed to a food system uniquely adapted to the high desert.²⁰¹

Collins was not the first outside researcher to study Hopi crops or foodways. In the late 19th century several anthropological expeditions made their way to the Hopi mesas, often part of larger excursions in the American Southwest that sought to document the region's indigenous cultures.²⁰² It was during such scientific expeditions that archaeologists, anthropologists, and ethnographers collected Hopi cultural property, including plant specimens and oral testimonies about Hopi foodways, often without permission of Hopi leaders. Researchers returned to their institutions, analyzed that which they had taken, and turned these observations of Hopi culture and resources into Western scientific knowledge used to bolster their careers, disciplines, and institutions. It is from these excursions, like the Hemenway Southwestern Archaeological Expedition, that some of the earliest Western analyses of Hopi foodways were constructed. And while such evidence is fragmentary, it provides a sort of historical baseline from which to compare changes in Hopi foodways, beginning with the first major shift in Hopi diet.

The first major shift in the Hopi diet occurred when the wild foods Hopis once utilized on a regular basis became less frequent guests at the Hopi table. Some of the earliest studies of Hopi food by Westerners focused on the relationship between Hopis and these wild foods, beginning with the work of Jesse Walter Fewkes in the early 1890s. It is important to place Fewkes' work at Hopi in historical context, as the knowledge and material he collected helped to build a career that would culminate in his appointment as Chief of the Bureau of American Ethnology in 1918.

²⁰¹ Nabhan, *Enduring Seeds*.

²⁰² Whiteley, *Rethinking Hopi Ethnography*, 7–8.

As director of the Hemenway Southwestern Archaeological Expedition in 1891, Fewkes moved the expedition from Zuni to Hopi in December of that year. Upon their arrival on the Hopi mesas, Fewkes tasked his assistant, Harvard University graduate student John Gundy Owens, with the collection of Hopi ethnobotanical data. While Fewkes had hoped to co-author an “elaborate memoir on the food and food resources of the Hopi” with Owens, he instead published a brief article in *The American Anthropologist* detailing the consumption of over thirty plants gathered and consumed by Hopis as a regular part of their diet, as well as the use of numerous others for medicinal and cultural purposes.²⁰³

By 1896 Fewkes was working as an ethnologist for the Bureau of American Ethnology. That summer he returned to the Hopi mesas, bringing with him a new field assistant – Walter Hough. Hough at once began building upon the earlier work of Fewkes and Owens, expanding the ethnologists’ knowledge of Hopi foodways. The young assistant documented Hopi consumption of nearly 50 non-cultivated food plants, while at the same time observing the intimate relationship between the Hopi people and their plant environment.²⁰⁴ Hough, who would go on to serve as the Head Curator of the Department of Anthropology at the U.S. National Museum during the 1920s and 1930s, noted that, “there is almost no plant to which the Hopi does not use in some way and no plant to which they have not given a name.”²⁰⁵ Even the small children with whom Hough spoke were able to tell him the names and uses of these plants, which

²⁰³ J. Walter Fewkes, “A Contribution to Ethnobotany,” *American Anthropologist* 9, no. 1 (January 1896): 14–21.

²⁰⁴ Walter Hough, “Environmental Interrelations in Arizona,” *American Anthropologist* 11, no. 5 (May 1898): 133–55.

²⁰⁵ Walter Hough, “The Hopi in Relation to Their Plant Environment,” *American Anthropologist* 10, no. 2 (February 1897): 35.

the anthropologist later corroborated through conversations with adults.²⁰⁶ Hough was, perhaps, transfixed by the children's botanical knowledge. "It seems to be part of the education of children," he reflected in 1898, "to familiarize them with the uses of plants, and to the knowledge of the writer this education begins early. The small children, if they can be induced to overcome their modesty, can usually give the names off hand."²⁰⁷ Hough's observations of the generational transmission of environmental and culinary knowledge in the late 19th century illuminate a world in which children, men, and women were intimately tangled in an ecological web where survival depended as much on knowledge as it did on the plants, animals, and water that sustained the Hopi people.

The gradual erosion of this knowledge was evident when Pearl Beaglehole conducted research on Hopi foodways in the 1930s. Beaglehole's research was part of what anthropologist Peter Whiteley calls the "proliferation of Hopi studies in the 1930s and 1940s" that coincided with broader historical processes including the Indian New Deal, the Indian Reorganization Act, and livestock reduction on the Hopi and Navajo reservations.²⁰⁸ When Beaglehole interviewed Irene and Yusi'ima in the 1930s, Irene's elderly uncle expressed regret for the loss of so many wild foods his mother and aunts had prepared during his childhood. His young, married niece often laughed when Yusi'ima described the "funnier" foods eaten sixty years earlier, plant foods of which Irene knew little. Together, she and her uncle identified eleven wilds food that were still being consumed by Hopis, a shocking decline indeed when compared with the forty-seven wild

²⁰⁶ Ibid., 36.

²⁰⁷ Hough, "Environmental Interrelations in Arizona."

²⁰⁸ Whiteley, *Rethinking Hopi Ethnography*, 8–10.

foods in use at the end of the 19th century.²⁰⁹ While it is impossible to draw a generalization about the exact state of Hopi consumption of wild foods during the 1930s based on Beaglehole's limited research, Yusi'ima's emotional testimony to the loss of these foods from his daily diet demonstrates an ongoing decline in wild food consumption at Hopi during the 20th century. At least in Yusi'ima's world, nearly 75% of wild foods had disappeared from Hopi meals in a little over a generation.

This loss affected not only dietary biodiversity, but culinary diversity as well. As Irene and Yusi'ima explained to Pearl Beaglehole on that summer day in 1934, the abandonment of wild foods had decreased the variety of meals served by Hopi women. Since every Hopi dish was in theory only served with another specific dish, fewer greens on the menu meant that the possibility of menu combinations was severely limited.²¹⁰ As such, culinary diversity became increasingly restricted as fewer and fewer wild foods made their way into Hopi kitchens.

Nearly a decade later, a team of researchers engaged in a joint project of the Office of Indian Affairs and the University of Chicago's Department of Anthropology made similar observations. At the initiation of Commissioner of Indian Affairs John Collier, these researchers ventured to the Hopi mesas in the spring of 1942 to study Hopi food and nutrition as part of a larger study of American Indian foodways in the Southwest.²¹¹ From an academic perspective, their work fits into broader efforts in the discipline of anthropology during this time to find

²⁰⁹ Beaglehole and Beaglehole, "Foods and Their Preparation," 69–70; Hough, "Environmental Interrelations in Arizona."

²¹⁰ Beaglehole and Beaglehole, "Foods and Their Preparation," 60.

²¹¹ Frederick Russell Eggan and Michel Pijoan, "Some Problems in the Study of Food and Nutrition," *America Indigena* 3, no. 1 (January 1943): 11.

solutions to perceived problems related to food.²¹² Viewing this research through the lens of American Indian policy, Collier initiated this cooperative project to study the foodways of American Indians in New Mexico and Arizona to “improve native standards of nutrition” that were in peril due to “the erosion, silting, and flooding consequent upon overgrazing and forest cutting, and the rise of wage labor.”²¹³ Researchers reported that consumption of wild foods had declined significantly in recent years, but that this dietary shift was likely a recent development resulting from overgrazing. Some Hopis, one researcher reported, “recognize livestock as the probable reason for the recent, more limited availability of many wild food plants that were, within living memory, known to the people in much larger quantity.”²¹⁴ While grazing might have contributed to a decline plant populations, it is likely that the increasing availability of cash and Western foods to be purchased with it had an even greater impact on the choice of many Hopis to gradually shift their culinary worlds away from the spaces where these plants once thrived toward the trading posts whose shelves were increasingly filled with flour, sugar, and coffee.²¹⁵ By the end of the century, only five plants were being gathered for culinary purposes.²¹⁶

²¹² Edward Montgomery and John W. Bennett, “Anthropological Studies of Food and Nutrition: The 1940s and the 1970s,” in *The Uses of Anthropology* (Washington: American Anthropological Association, 1979), 132–3.

²¹³ Eggan and Pijoan, “Some Problems in the Study of Food and Nutrition,” 10.

²¹⁴ James B. Watson, “The Historical Development of Hopi Economy and Its Relations to Other Aspects of Culture” (M.A., University of Chicago, 1945), 64.

²¹⁵ Hopi man, interview by Tai Johnson, First Mesa, Arizona, August 3, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona; Hopi man, interview by Tai Johnson, First Mesa, Arizona, August 17, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

²¹⁶ Brenton, “Hopi Foodways: Biocultural Perspectives on Change and Contradiction,” 94, 111.

The decline in wild food consumption facilitated a downward shift in dietary biodiversity, culinary diversity, and the generational transmission of environmental and cultural knowledge. By the end of World War II many of the younger generation had become acquainted with non-Hopi foods through the time they spent away from home in government boarding schools.²¹⁷ One ethnobotanist connected the boarding school experience with the decline in wild food consumption, a loss of traditional knowledge, and impending nutritional deficiencies. Writing in 1946, George F. Carter observed, “It is the old folks who know the herbs and greens. The young folk tend to be contemptuous of them and to turn instead to white man’s food such as white flour, canned goods, etc.” This, Carter continued, was “a curious turn of affairs for in abandoning the old herbs, the youth are abandoning the folk wisdom of their ancestors. For the probably vitamin rich greens of their environs, to be had for the picking, they are turning to impoverished white flour and devitalized canned goods.”²¹⁸

This turn to “impoverished white flour” was already underway by the 1930s, despite the fact that Hopis were still producing most of their own food. While Hopis were producing 71% of their own food in 1936, they purchased 29% of it from local trading posts.²¹⁹ In 1936 Hopis purchased 529,300 pounds of wheat, including flour, averaging 190.5 pounds per Hopi that year.²²⁰ Wheat, therefore, constituted 64% of all Hopi purchased imports.²²¹ The introduction of wheat flour into the Hopi diet was a major culinary shift. More than any other meal, it was the

²¹⁷ See Matthew Sakiestewa Gilbert’s study of Hopi students’ experiences at the Sherman Institute in Riverside, California. The Hopi boarding school experience is a subject that several interviewees for this project discussed in terms of exposure to non-Hopi foods. See Matthew Sakiestewa Gilbert, *Education beyond the Mesas: Hopi Students at Sherman Institute, 1902-1929* (Lincoln: University of Nebraska Press, 2010).

²¹⁸ George F. Carter, “Some Hopi Indian Food Herbs,” *The Herbarist* 12 (1946): 35.

²¹⁹ U.S. Soil Conservation Service, *Dependency Survey*, 1936, Table XXIX.

²²⁰ *Ibid.*, Table XXXIX.

²²¹ *Ibid.*, Table XXXII.

Hopi breakfast that changed the most after flour entered the kitchen. By the mid-1930s Hopi women were rising early in the morning to make fried bread or baking powder biscuits to feed their families.²²² This practice often replaced a more traditional Hopi breakfast that included corn dumplings, gravy, and chile, referred to as blue balls.²²³ The refined grain also made its way into tortillas, which were then fried in lard.²²⁴ And by the 1940s white flour was “almost as much a staple in the Hopi diet as corn or beans.”²²⁵ Coffee and tea had supplanted indigenous brews made of local plants as the drinks of choice, and sugar was making its way into Hopi kitchens and bodies.²²⁶

Sugar was indeed a revolutionary addition to the Hopi diet - one that elicited desire, was highly sought after, and gradually replaced locally produced sweeteners. The history of sugar consumption on the Hopi mesas is in some ways similar to that documented by anthropologist Sidney Mintz in the British Empire from the 17th through the 19th century, particularly in its transformation from curiosity to commonplace, the shifting nature of its use and meaning over time, and the replacement of locally produced foods with imports.²²⁷ One of the earliest written records of sugar’s introduction at Hopi comes from an anthropologist who visited the reservation in 1913. She reported, “ten families in Walpi and Sichomovi were said (on March 23rd) to have

²²² Beaglehole and Beaglehole, “Foods and Their Preparation,” 68.

²²³ Beaglehole and Beaglehole, “Foods and Their Preparation,” 64-65; Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, June 29, 2007, interview by Tai Johnson, First Mesa, Arizona, August 3, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

²²⁴ Mischa Titiev, *Old Oraibi: A Study of the Hopi Indians of Third Mesa* (Cambridge, Mass.: Published by the Museum, 1944), 199.

²²⁵ Watson, “The Historical Development of Hopi Economy and Its Relations to Other Aspects of Culture,” 77.

²²⁶ Titiev, *Old Oraibi*, 199.

²²⁷ See Sidney Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (New York: Viking, 1985).

come to the end of their corn – the women had traded too much for sugar and other dainties. Some sold their black dresses, some made batches of tourist pottery for the store keepers in exchange for flour.”²²⁸ It appears as though these women desired sugar to such a great extent that they willingly depleted their stores of corn (which most women stockpiled to feed their families for three years in case of drought) in order to purchase sugar. This depletion, in turn, led them to trade arts and crafts in order to purchase wheat flour to replace the squandered corn.

Once sugar appeared on the Hopi mesas, it replaced traditional sweeteners for those who could purchase or trade for it. As late as the 1930s, some older women were still using more traditional methods of sweetening food. Pearl Beaglehole recorded the rapidly changing nature of sweetening Hopi foods during her fieldwork in 1932 and 1934, which reveals much about dietary and economic shifts during this time.

A sweet sauce is sometimes added to the batter of a corn dish. It is prepared while grinding or performing other tasks on the day it is needed. She takes a pinch of white corn meal in her mouth and chews it until, by the action of saliva, it becomes creamy. She spits the liquid into a bowl and she repeats the process until she has filled the vessel. This was the old method of sweetening food. It is now almost completely superseded by the use of wheat seeds obtained through trade; these are soaked till soft, strained, and allowed to stand until the shells drop off the kernels. They are then thoroughly dried, ground very fine, and added to the meal to be sweetened. The use of wheat seeds is preferable to that of sugar, for the latter tends to harden a batter, while wheat is satisfactory in any batter, thick or thin. . . . A wild plant said to be like wheat, is infrequently used as a wheat substitute.²²⁹

What Pearl Beaglehole reported in the 1930s was a shift from the use of a wild food, “the old method,” to sweeten foods to the trade and purchase of wheat and sugar. By the 1950s, sugar

²²⁸ C Forde, “Hopi Agriculture and Land Ownership,” *Journal of the Anthropological Institute of Great Britain and Ireland* 61 (1931): 393.

²²⁹ Beaglehole and Beaglehole, “Foods and Their Preparation,” 63.

had become commonplace in many Hopi households, procured from local trading posts along with items such as commercial salt, which replaced salt traditionally mined by Hopis in the Grand Canyon and brought back to the mesas. However, some Hopi women still preferred the “wild plant said to be like wheat” to sweeten their puddings as late as the 1950s, including those with access to sugar. While one Third Mesa farmer remembers that sugar was “always in my family,” he also recalls his father cultivating a “wild native wheat” for his mother who used it to sweeten traditional Hopi dishes. Each fall his father would gather the seeds and plant them in a particular section of his farm because the women “wanted the wheat for the puddings.”²³⁰

This farmer’s practice underscores the ways that dietary change was a negotiated process and demonstrates that culinary patterns often persisted in conjunction with the adoption of new foods. Hopis did not simply abandon traditional foods in favor of their Western counterparts, but rather chose foods that would serve their culinary needs. Hopis added new foods to traditional menus gradually, often serving them alongside Hopi dishes prepared as they had been for centuries. Hopis growing up in the 1940s recall this gradual transition as new foods appeared on the table alongside traditional staples. During these years traditional foods remained central to Hopi culture and identity. “Our mothers prepared all kinds of food from our corn, like *piiki* bread and blue balls,” a Second Mesa farmer explained to me. “We grew up eating it and that’s our nutrition. It’s our best food. We came into the world with that corn.”²³¹ His mother preserved

²³⁰ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, June 29, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona; Hopi man, interview by Tai Johnson, First Mesa, Arizona, August 3, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona; Hopi man, interview by author, Kykotsmovi, Arizona, June 5, 2013.

²³¹ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, June 29, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

Hopi foods so that they might eat them year-round, supplementing them with store-bought staples such as eggs and potatoes.

The importance of growing and eating Hopi crops endured as a cultural value, transmitted to Hopi children from their elders, and more often than not linked to physical survival. A Hopi-Tewa farmer who grew up in the 1940s and 1950s recalls the urgency with which his elders, who were witnessing significant socioeconomic transition at the time, transmitted these values to him. The elders stressed that learning how to produce food using traditional agricultural knowledge and technique “is what’s going to keep you alive.” If you learned how to plant, purchasing food would not be necessary because, as the older farmers told him, “you got your own things to eat.”²³²

For this farmer and many others, survival depended on one’s ability to grow food. This ability, in turn, rested on the transmission of agricultural and environmental knowledge from one generation to the next. The sustainability of this ancestral food system was deeply rooted in the generational transmission of agricultural, ecological, and culinary knowledge. Hopi men, women, and children maintained these systems of knowledge throughout the 1940s and 1950s, despite the economic restructuring of their society that was occurring. Grandfather, uncles, and fathers taught their young sons to cultivate the land, while mothers, aunts, and grandmothers instructed Hopi girls in the processing, preservation, and preparation of Hopi foods. Despite the addition of purchased foodstuffs like sugar, wheat, eggs, and coffee, rates of culinary and crop

²³² Hopi man, interview by author, First Mesa, Arizona, August 3, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

diversity remained high as families actively engaged in the production of their own food through the physical activities of farming, herding, gathering, preparing, and storing foods.²³³

A family's access to cash-often earned through wage labor, livestock sales, or the marketing of arts and crafts-limited the purchase of non-Hopi foods. For most families, meals consisted primarily of foods cultivated, raised, and gathered on Hopi lands. For many, a lack of cash resources meant that survival was still tied to the local environment and maintenance of the food system it supported, as a First Mesa farmer recalled when discussing his childhood during the 1940s with me. "When I was growing up there was hardly anything that we'd get from the store," he recalled.²³⁴ They never worried about meat because they had sheep, and their vegetables were all grown in the fields and gardens, supplemented with plants gathered from the land.

The garden vegetables and wild greens that filled this young boy's stomach were carefully cultivated, prepared and preserved by Hopi women along with the diverse array of dry farmed corn, beans, squash, and melons grown by Hopi men to ensure year-round subsistence on a traditional diet. Hopi women actively preserved these highly nutritional foods as their mothers, aunts, and grandmothers had done for generations. Food preservation by Hopi women, like farming was for their male counterparts, remained a central component of Hopi survival and persistence, in both a cultural and physiological context. As this farmer recalled, food preservation was key at this time because his family had little cash with which to buy food.

²³³ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013; Hopi man, interview by author, Moenkopi, Arizona, November 7, 2013; Hopi woman, interview by Tai Johnson, Bacavi, Arizona, August 17, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona; 1964 Crop Survey, Alfred F. Whiting Collection, MS 25, Northern Arizona University Cline Library, Flagstaff, Arizona.

²³⁴ Hopi man, interview by Tai Johnson, First Mesa, Arizona, August 3, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

“Mostly everything,” he reflected, “we always preserved it for winter because at that time we didn’t have no stores. Nobody had hardly any money, so there was a way of keeping our foods.”

235

While most of the food this young boy’s family consumed originated from crops they grew themselves, the cash his father earned by selling livestock gave the boy a small taste of foods that elicited excitement, even awe. The flour, salt, and baking powder purchased at the local trading post were not of great interest to the boy and his brothers, but the candy his father brought home left a gastronomic memory that remains vivid to this day.

The funny part is we never used to know what candy is. Until my father kills a sheep, takes it to the store, he sells the carcass to the store after he butchers it, and then the store sells the meat to the people. So they pay him for that. And one time he came home with a bag of mixed candy. And we’re looking, ‘What’s that?!?’ We didn’t know what it was, kept looking. And that’s when he said, ‘Oh, that’s candy. It’s good.’ So he took one out and put it in our mouth and it was sweet. But our oldest brother, he was in charge of that candy. Nobody would get to that candy. He was the only one that would give one candy to each person, every day, one candy, that’s all.²³⁶

The doling out of one piece of candy a day to each child undoubtedly changed the children’s perception of sweetness, shifting snacking away from local and organic foods toward highly processed industrial food products. Before Hopi children began snacking on candy, a sweet tooth or the urge for an after school snack was satisfied with fruit grown in local orchards – a different kind of candy, as this farmer from the village of Moenkopi explained to me. “Dried peaches and apricots - those were always set out or cut and then split in half and dried out,” he recalled. “That’s what we called candy. ‘Cause during that time, when I was going to Day

²³⁵ Hopi man, interview by author, First Mesa, Arizona, August 3, 2007.

²³⁶ Hopi man, interview by author, First Mesa, Arizona, August 3, 2007.

School here, candy wasn't really around. So we would use that to satisfy our urges, like eating something after school."²³⁷

Hopi peaches were just one crop variety Hopi women prepared for their children as a snack. When I spoke with a farmer from the Third Mesa village of Bacavi on a brisk afternoon in early November, he shared his memories of a favorite childhood snack – popcorn made from Hopi red corn - a variety he does not see grown as frequently as it was during his childhood. In the fall older women in his village would shell the freshly harvested red corn of which several varieties were grown. They would then parch it in a special kind of loamy soil in a metal kettle, “extract it from the kettle, sift it, and then while it’s hot sprinkle a little salt water on it so you get a salty taste. And as kids, that’s the food that we snacked on this time of the year and from now on. But we don’t see that much anymore.”²³⁸

He thinks there might be a connection between people not consuming a particular snack or dish and the variety of crop needed to make that traditional food not being planted as frequently. “Let me put it this way,” he explained. “As we grew older, candy, sweets, and soda pop began to take over these traditional snacks.”²³⁹ By the late 1950s and 1960s snack foods and beverages like soda and candy had were a common part of the diets of Hopi children. Local trading posts made these items readily available to all ages of Hopis. “Soda pop was always available,” a Third Mesa farmer recalled. “They had these nice little cans, kind of like little modern oilcans.” The local trading post cooled the soda in iceboxes with “big, huge ice” blocks on the sides and the Coke in the center. And so, he quipped, “I grew up with pop or soda all my

²³⁷ Hopi man, interview by author, Moenkopi, Arizona, November 7, 2013.

²³⁸ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

²³⁹ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

life.”²⁴⁰ The widespread availability of such beverages and snack foods likely shaped Hopi tastes and hence, food preferences, as historians and anthropologists have documented in other culinary, geographic, and temporal contexts.²⁴¹

In addition to new foods being introduced into the Hopi diet via the local trading post, familiar foods produced off the reservation were also brought to Hopi land by non-Hopis and sold to those with enough cash to purchase them. These foods included fruit grown in far away locales, sold by a character remembered by many as the Fruit Man.²⁴²

In the...early sixties, a big bus would come out. We called him the Fruit Man. I don't know where he came from, but he would have a schedule throughout the Hopi villages. He would honk and people would go up there. It was a big bus, a white bus, and it was packed with fresh fruit. So early on, in the late fifties, early sixties we were able to get cherries, 'cause he brought those. And womanfolks would rush over there and try to fight for the best.²⁴³

While the Fruit Man brought items not traditionally grown on the Hopi mesas, like cherries, he also supplied villagers with peaches, apples and apricots – all fruits traditionally cultivated by Hopis. And, as this woman's recollection demonstrates, outside foods like the fruits peddled by the Fruit Man, were in high demand on the Hopi mesas. This was, perhaps, in part due to the fact that by the 1960s, some orchards were not maintained as they had been in the past

²⁴⁰ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, June 29, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

²⁴¹ Amy Bentley, *Inventing Baby Food: Taste, Health, and the Industrialization of the American Diet* (Oakland, California: University of California Press, 2014); Sidney W. Mintz, *Sweetness and Power: The Place of Sugar in Modern History*, Reprint edition (New York: Penguin Books, 1986); Gabriella M Petrick, “The Arbiters of Taste: Producers, Consumers and the Industrialization of Taste in America, 1900-1960” (University of Delaware, 2006).

²⁴² Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, June 29, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona; Hopi woman, interview by author, Camp Verde, Arizona, June 27, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

²⁴³ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, June 29, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona

and Hopis were not producing enough fruit to fulfill their desires. This disconnect between local supply and demand created an opening through which non-local crop varieties replaced locally adapted cultivars in the Hopi diet.

Despite the introduction of items like the Fruit Man's cherries, soda, and coffee, foods purchased by Hopis did not fully replace but rather supplemented traditional foods in the 1960s. Men, women, and children continued mixing traditional cuisine with modern foods as both access and cash flow increased. In addition to local trading posts, grocery stores in border towns like Flagstaff and Winslow provided Hopis with opportunities to try new foods or, as one woman remembered, get "hooked."

I remember when we first started. During that time nobody had TV. I was a teenager and nobody had a ride, like a vehicle. But there would be this one man from Hotevilla. He used to come around to what they called the fatherless kids or mothers that are just single parents. He used to come around and he would ask the families, 'Would you guys like to pitch in this month to go to town?' And at that time that was a lot, to pay like 20 to 30 dollars to him to take us into Flagstaff. And sometimes you bought him his lunch or bought extra groceries and give it to him. But we would all do that. Three or four families would all pitch in and we'd all climb into his truck. And everybody would be getting all doozied up and they'd get in the back and then you still have this blanket over you 'cause you're trying not to get dusty 'cause the dirt road still used to be there from Leupp to K-town. It was still a dirt road and it was still like washboard. (She laughs.) You clean up the day before and you get to town and you're all dusty and white. (She laughs again.) We would go over there and everyone would just purchase what they need for almost a month, I guess. I remember us getting hooked on sugar, coffee... white flour, and different things that you start trying out.²⁴⁴

²⁴⁴ Hopi woman, interview by Tai Johnson, Bacavi, Arizona, August 17, 2007, Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, June 29, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

This woman's recollection of traveling the long, dusty, washboard road from the Hopi village of Kykotsmovi to Leupp, and then on to Flagstaff illustrates the extent to which some Hopis went to acquire groceries in the 1960s as well as to the continuing melding of Hopi foodways with their Western counterparts. While single mothers often depended on community members to drive them into "town" to purchase food items, other women depended on husbands and grandfathers working off the reservation to bring back groceries when they returned from weekly or seasonal job posts. A woman from Second Mesa vividly remembered her grandfather's trips home to the reservation after seasonal wage labor employment as a journeyman contractor during the 1960s, work that "required him to be gone some part of the year to be able to provide." "But he did come back home," she recalled, "And of course - because he was the wage earner - he brought groceries."²⁴⁵

For many Hopi men, employment off the reservation was the only opportunity available for them to earn cash. What it meant to be a Hopi man was changing along with shifting socioeconomic circumstances, most notably the rise in wage labor detailed in the first chapter of this dissertation. An influx of cash and the ability to purchase food rather than or in addition to growing it often resulted in new human relationships to food and the environment. Hopis were no longer dependent on the environment for their survival if enough cash could be earned to purchase food at the local trading post or a border town grocery store. Buying food instead of or in addition to growing it became a widely accepted adaptation to traditional Hopi life as men laboring away from home during the week returned with groceries for their families. This movement of labor and food in some ways mirrors processes occurring in southern Arizona. By

²⁴⁵ Hopi woman, interview by Tai Johnson, Kykotsmovi, Arizona, July 6, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

the early 1950s at least half the food consumed on the Tohono O’odham reservation was purchased, often with wages earned in the cotton fields. There, like on the Hopi reservation, items like flour, sugar, and coffee made their way home with wage laborers at the end of a season or a workweek.²⁴⁶

For some, it was the procurement of regular employment that signified the shift away from a more traditional diet. “When my grandfather started working and getting a paycheck from the Forest Service, he was able to provide groceries for my family,” a Third Mesa farmer recalled. “He used to come home with a whole bunch of groceries on Friday when he came home from work.”²⁴⁷ His grandfather continued working for the U.S. Forest Service throughout the 1970s, bringing groceries home each weekend to feed his extended family. This trend intensified across the reservation during this time.

As more and more Western food made its way into Hopi villages, the scope and diversity of traditional dishes faded in many households. A woman from Second Mesa spoke to me about this transition away from traditional foods, which was punctuated by her departure and eventual return to her home on the mesas.

As I grew older, I went away. I came back and I noticed that my family had gone a lot to eating things that were purchased at the store. We started eating a lot more meat. We didn’t used to eat a whole lot of meat. We used to eat a lot of corn, things that came from blue cornmeal or things that had been preserved over the winter months. We used to eat a lot of peaches, dried peaches. And I noticed were drawn away from that as more foods were being purchased from the store.²⁴⁸

²⁴⁶ Dobyns, *Papagos in the Cotton Fields*, 77, 84.

²⁴⁷ Hopi man, interview by Tai Johnson, Kykotsmovi, Arizona, July 6, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

²⁴⁸ Hopi woman, interview by Tai Johnson, Kykotsmovi, Arizona, July 6, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

A farmer who grew up in Hotevilla also recalled his departure from the reservation in the early 1970s as significant in the transition away from traditional foods. For him, the first significant shift in his daily foodways occurred when he left the reservation to attend junior high and high school in Winslow where he lived in a Bureau of Indian Affairs dormitory. Many of the foods served there, he recalls, were USDA commodity food products. He also became exposed to fast food options while living away from the Hopi mesas. This was quite different from his elementary school experience where he ate only lunch at school each day, and the rest of his meals were primarily traditional Hopi foods served at home.²⁴⁹

While some Hopis, like this farmer, encountered non-Hopi foods primarily through their experiences off the reservation. Others experienced some of these same foods, including government commodity foods, via federal and state food assistance programs that were either created or expanded in the 1960s and 1970s throughout Indian Country and the United States as a whole.²⁵⁰ The introduction of foods through these programs is important in terms of both human health and dietary diversity, as many government food programs provided Hopis with food products processed from monoculture crops and livestock raised thousands of miles away from the Hopi mesas.

²⁴⁹ Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

²⁵⁰ D. H Calloway, R. D Giauque, and F. M Costa, "The Superior Mineral Content of Some American Indian Foods in Comparison to Federally Donated Counterpart Commodities," *Ecology of Food and Nutrition Ecology of Food and Nutrition* 3, no. 3 (1974): 203–11; D. H Calloway and J. C Gibbs, "Food Patterns and Food Assistance Programs in the Cocopah Indian Community," *Ecology of Food and Nutrition Ecology of Food and Nutrition* 5, no. 4 (1976): 183–96; Hopi man, interview by author, Kykotsmovi, Arizona, April 24, 2013.

Many of the food programs instituted on the Hopi Reservation were rooted in a growing awareness of hunger and malnutrition amongst the U.S. populace at large.²⁵¹ Partially in response to public outcry, the federal government created or expanded a broad swath of food assistance programs during the 1960s and 1970s including the School Lunch Program, Congregate Meals, Meals on Wheels, Women Infants and Children (WIC) Program, Commodity Supplemental Food Program, and Food Stamps. The Office of Economic Opportunity, which administered War on Poverty programs nationwide during the early 1960s, also distributed food through local programs such as the Hopi Action Program.²⁵²

For example, in the late 1960s and early 1970s the Emergency Food Program of the Hopi Action program distributed baby food, formula, and evaporated milk to Hopi mothers and infants.²⁵³ The distribution and subsequent consumption of infant formula was a significant change to the diets of Hopi babies who participated in the program. Rather than being nourished by the breast milk of mothers who had spent their childhoods consuming traditional Hopi foods, they were instead nourished by an industrialized food product, one that remains a topic of debate

²⁵¹ For a brief discussion of the “discovery” of hunger in America and shifts in food assistance programs, see Annelise Orleck, *The War on Poverty: a New Grassroots History, 1964-1980* (Athens: University of Georgia Press, 2011), 136-139.

²⁵² For an examination of federal food assistance programs during President Lyndon Baines Johnson’s War on Poverty, see Norwood Allen Kerr, “Drafted into the War on Poverty: USDA Food and Nutrition Programs, 1961-1969,” *Agricultural History* 64, no. 2 (April 1990): 154–66; For a history of the School Lunch Program, see Susan Levine, *School Lunch Politics: The Surprising History of America’s Favorite Welfare Program* (Princeton: Princeton University Press, 2010); For a brief overview of the history of the Women, Infants, and Children Program (WIC), see Victor J Oliveira et al., *The WIC Program: Background, Trends, and Issues* (Washington, DC: U.S. Dept. of Agriculture, Economic Research Service, 2002), 7-12; Hopi WIC Program Expands, Offers Open Enrollment,” *Tutuveni*, July 29, 1994; . . .

²⁵³ “\$372,085 in OEO Funds Granted Tribe,” *Winslow Mail*, July 10, 1969; “Surplus Food Distribution Set,” *Winslow Mail*, June 11, 1970; “Program Directors Announce Cut in Canned Milk Distribution,” *Winslow Mail*, March 25, 1971; “Distribution of Commodities,” *Winslow Mail*, July 29, 1971; “Distribution of Commodities,” *Winslow Mail*, December 30, 1971.

to this day.²⁵⁴ The addition of manufactured baby food to the diet of Hopi infants was also a significant change. Historian Amy Bentley argues that the industrialization of baby food was critical in shaping the food preferences of Americans, and that its consumption “may have helped prime Americans’ palates for the highly processed industrialized products that have contributed to our health problems today.”²⁵⁵ Whether or not this is the case for Hopis is unclear based on the evidence available, but shifts in the ways Hopi children received nourishment continued throughout the rest of the 20th century.

One such shift was the introduction of the WIC program. Beginning in 1972 some Hopis received food assistance through the Special Supplemental Food Program for Women, Infants, and Children, commonly referred to as WIC. The program provided food assistance, including cereal, juice, beans, peanut butter, eggs, and cheese to women who were pregnant or lactating and children under five years old.²⁵⁶ By the late 1970s the program had the capacity to serve 900 Hopis out of its Keams Canyon office. The scale of the program allowed its director to make some keen observations about the relationship between economic development and human health. Speaking with a journalist for the Hopi newspaper *Tutuveni* in 1979, the director stated she observed that infants and children who came from lower income families were in better health than children whose parents had higher incomes. The discrepancy in health, she believed,

²⁵⁴ See Amy Bentley, “Feeding Baby, Teaching Mother: Gerber and the Evolution of Infant Feeding Practices in the United States,” in *From Betty Crocker to Feminist Food Studies: Critical Perspectives on Women and Food* (Amherst: University of Massachusetts Press, 2005), 62-63.

²⁵⁵ Bentley, *Inventing Baby Food*, 6.

²⁵⁶ “Hopi WIC Program Changes Agencies,” *Tutuveni*, September 23, 1993.

was due in part to the fact that low-income parents purchased only essential foods while those with more disposable cash purchased products such as candy, soft drinks, and high fat foods.²⁵⁷

Hopis like the director of the WIC program were not the only ones concerned about possible nutritional differences between traditional foods and Western foods, including those the federal government distributed through various programs. In the early 1970s, Hopis received nontraditional foods through the Commodity Supplemental Food Program, which provided free commodity foods to low-income, nutritionally at-risk pregnant women, postpartum women, and children under six years old.²⁵⁸ The program distributed commodity foods to at least 272 Hopi families between 1970 and 1973, including de-germinated yellow cornmeal, enriched white flour, corn syrup, and pinto beans.²⁵⁹

During this time Hopis working for the Cooperative Extension Service collaborated with a team of researchers from the Department of Nutritional Sciences and Lawrence Berkeley Laboratories at the University of California, Berkeley to analyze commodity foods distributed to Hopis in 1970 and 1971 alongside traditional Hopi foods for their nutritional value. Doris Howes Calloway, a scientist who took “occasional forays into real-world nutrition problems,” and was concerned with the consequences of commodity food consumption led the team.²⁶⁰ Cooperative

²⁵⁷ “WIC Program Assists Hopis,” *Qua'toqti*, January 18, 1979; “Hopi WIC Program Expands, Offers Open Enrollment,” *Tutuveni*, July 29, 1994.

²⁵⁸ Oliveira et al., *The WIC Program: Background, Trends, and Issues*, 7.

²⁵⁹ “Surplus Food Distribution Set,” *Winslow Mail*, June 11, 1970; “Program Directors Announce Cut in Canned Milk Distribution,” *Winslow Mail*, March 25, 1971; “Distribution of Commodities,” *Winslow Mail*, July 29, 1971; “Distribution of Commodities,” *Winslow Mail*, December 30, 1971; Food Stamp Survey,” *Winslow Mail*, April 18, 1974; D.H. Calloway, R.D. Giaque, and F.M. Costa, “The Superior Mineral Content of Some American Indian Foods in Comparison to Federally Donated Counterpart Commodities,” *Ecology of Food and Nutrition* 3 (1974): 203-205.

²⁶⁰ Janet C. King, “Doris Howes Calloway (1923–2001),” *The Journal of Nutrition* 133, no. 7 (July 1, 2003): 2115.

Extension Service home economist Juanita Kavena arranged for the collection of Hopi foods. Several Hopi women contributed food and carefully instructed the researchers in its preparation. The team found Hopi crops prepared with traditional culinary practices were far more nutritional than their highly refined commodity counterparts. Hopi corn meal was significantly higher in protein, and contained four times as much zinc and magnesium, three times as much potassium and manganese, and twice as much calcium, phosphorus, and copper as the commodity cornmeal. Hopi cornmeal was also twice as high in iron, even though the commodity cornmeal had been enriched with the nutrient.²⁶¹

Researchers then tested *piiki* and blue marbles - traditional corn dishes to which Hopi women add the ash of bean pods or four-wing saltbush – for their nutritional content. They first analyzed the ashes of bean pods and four-wing saltbush gathered on the reservation, finding significant levels of potassium, calcium, and magnesium that “constitute a broad-spectrum mineral supplement to Hopi cuisine.”²⁶² When added to *piiki* batter, the cooked *piiki* “contained at least 35 times as much calcium, three times as much manganese and about twice as much iron, zinc, and copper” as the Hopi blue corn meal from which it was made, “as well as three times the level of iron specified by current federal enrichment standards for breads and cereals.”²⁶³ The blue marbles made with four-wing saltbush ash showed “nutritionally significant increases” in iron, zinc, potassium, and manganese and a stunning 63-fold increase in calcium compared to the Hopi blue corn meal from which the traditional dish had been made.²⁶⁴ The researchers observed that many Hopi women were using baking soda rather than plant ash in the preparation of

²⁶¹ Calloway, Giaque, and Costa, “The Superior Mineral Content of Some American Indian Foods in Comparison to Federally Donated Counterpart Commodities,” 203–204.

²⁶² *Ibid.*, 206.

²⁶³ *Ibid.*

²⁶⁴ *Ibid.*, 207.

traditional foods. “This could be unfortunate,” they lamented, “because the addition of ash” to corn batter raised the food’s nutritional value “to about half the estimated need of calcium, manganese, and zinc and all of the required magnesium and iron.”²⁶⁵

It is important to recognize that dietary knowledge is constructed, fluid, and influenced by factors including culture, politics, and economics.²⁶⁶ Calloway and her team measured distinct elements of both Hopi and commodity foods against nutritional standards set by the United States Department of Agriculture, standards that are continually evolving. The scientists concluded that Hopis, “have a much better probability of meeting mineral needs from locally grown and traditionally prepared plant foods than from...most of the commodities they have been given.”²⁶⁷ The Commodity Supplemental Food Program was discontinued in 1973 when the Food Stamps program was adopted, enabling low-income Hopi families to purchase a significant quantity of food for the first time.²⁶⁸

Another program that played a critical role in changing dietary patterns among the Hopi is the federal School Lunch Program. Historian Susan Levine argues that the foods served depend not so much on the nutritional needs of children, but more so on surplus commodities thereby linking “children’s nutrition to the priorities of agricultural and commercial food

²⁶⁵ Ibid., 210.

²⁶⁶ Charlotte Biltekoff, *Eating Right in America: The Cultural Politics of Food and Health* (Durham: Duke University Press Books, 2013); Jessica J. Mudry, *Measured Meals: Nutrition in America* (Albany: State University of New York Press, 2010); Marion Nestle, *Food Politics: How the Food Industry Influences Nutrition and Health* (Berkeley: University of California Press, 2013).

²⁶⁷ Calloway, Giauque, and Costa, “The Superior Mineral Content of Some American Indian Foods in Comparison to Federally Donated Counterpart Commodities,” 209.

²⁶⁸ H.V. Kuhnlein and D.H. Calloway, “Contemporary Hopi Food Intake Patterns,” *Ecology of Food and Nutrition* 6 (1977): 171.

interests.”²⁶⁹ The program supplied schools on the Hopi Reservation with food products from Gallup, New Mexico every two weeks, from which school cooks created student favorites like “enchilada pie” from tortillas, cheese and ground beef, and “Navajo tacos” made of fry bread, beef chili, and cheese.²⁷⁰ A newspaper article titled “140 hamburgers and fries to go, please” reveals a typical week of main dishes at Hopi schools included hot dogs, grilled steak, beef stew, rolled turkey, and spaghetti with meat sauce. All were accompanied by milk, canned or fried vegetables, canned fruit, and dessert such as pineapple upside down cake or jellied applesauce salad. A menu printed three months later is identical in content, suggesting the limited diversity of foods served in Hopi schools.²⁷¹ Instead, processed beef, refined wheat products, sugar, milk, processed cheese, and canned fruits and vegetables formed the basis of lunches for students attending Hopi schools. The consumption of these foods by Hopi children links their experience to that of kids across the country eating similar menus.

By the 1970s, the extent to which these and other non-Hopi foods had replaced traditional foods was considerable. The extent to which these and other non-Hopi foods purchased or received by Hopis had affected culinary diversity and overall consumption of traditional foods by the 1970s was considerable. A study of the contemporary Hopi diet conducted in the mid-1970s revealed that less than 25% of Hopis were eating at least one traditional dish each day, and that culinary diversity had declined significantly over the course of the 20th century.²⁷² The study’s authors found “that although many cooks (especially the older ones) may be familiar

²⁶⁹ Levine, *School Lunch Politics*, 3–4.

²⁷⁰ “140 Hamburgers and Fries, To Go, Please,” *Qua’toqti*, January 24, 1974.

²⁷¹ “140 Hamburgers and Fries, To Go, Please,” *Qua’toqti*, January 24, 1974; “School Lunch Menu,” *Qua’toqti*, March 21, 1974.

²⁷² Calloway, D.H. and H.V. Kuhnlein, “Contemporary Hopi Food Intake Patterns,” *Ecology of Food and Nutrition* 6, no. 3 (1977): 159.

with many different corn dishes, and even prepare them on occasion only three or four traditional corn dishes are served to less than one-quarter of the families living in Hopiland.”²⁷³ They also found that the five wild greens Pearl Beaglehole reported in use by cooks on Second Mesa during the 1930s, “do not appear to be a part of typical Hopi diets, although a few elderly women on Third Mesa are known to collect them periodically, and many Hopi know wild greens are edible and can identify a few.”²⁷⁴ During the high season for collecting greens in 1976, 11% of school children reported being served some type of wild food at home, leading the researchers to conclude these foods had become a seasonal item for some families, but “drying for year-round use is no longer common.”²⁷⁵ Many older Hopi women expressed concern “that the young people are no longer learning how to produce and prepare the old foods,” which the elders recognized as “giving good health.”²⁷⁶

Hopi foods were increasingly replaced with items including highly refined wheat products like bread, wheat, and pasta, potatoes, canned fruits and vegetables, milk, and sugary drinks like soda, and Kool-Aid.²⁷⁷ Twenty-seven percent of the children surveyed drank Kool-Aid or cola as an afternoon or evening snack on school days, and forty-three percent reported drinking one of these beverages at least once on the weekend.²⁷⁸ A study conducted twenty years later revealed that Hopi children were consuming a diet that consisted primarily of beef, mutton, eggs, store-bought bread, canned vegetables, fruit, and fruit juices, potatoes, lard, coffee, tea, milk, soft drink mixes, soda, commercial pastries, and sweet and salty snacks. Their diets

²⁷³ Ibid., 166.

²⁷⁴ Ibid., 165.

²⁷⁵ Ibid.

²⁷⁶ Ibid., 172.

²⁷⁷ Ibid., 169-172.

²⁷⁸ Ibid., 169.

contained few fresh fruits or vegetables, and excessive amounts of refined cereals, animal fats, and foods rich in sucrose, none of which were part of the traditional Hopi diet.²⁷⁹ The 1991 survey reveal diets that exceeded the recommended daily intakes for energy, fat, cholesterol, sodium, and refined sugars, and that were too low in zinc, calcium, vitamin D, fiber, and complex carbohydrates.²⁸⁰

By the 1990s the Hopi diet was no longer based on traditional foods. Hopi women surveyed in 1991 reported that they purchased the majority of their food in grocery stores.²⁸¹ Only 9% of meals they prepared included a traditional food, a significant decline from 1974 when 25% of women reported preparing at least one traditional food a day.²⁸² Hopi women prepared an average of only five different traditional dishes in 1991, compared to nearly seventy dishes recorded by Pearl Beaglehole in the 1930s.²⁸³ And while almost half of the women surveyed in the early 1990s collected wild foods, only five different plants were gathered.²⁸⁴

Over the course of only two generations, biodiversity in the Hopi diet and culinary diversity among traditional foods plummeted. Hopi bodies, once nourished by a plethora of plants prepared in countless ways, were now fueled primarily by highly processed foods produced in industrialized settings from monoculture crops and animals. This homogenization of

²⁷⁹ Barrett Brenton and Amy C. Brown, "Dietary Survey of Hopi Native American Elementary Students," *Journal of the American Dietetic Association* 94, no. 5 (May 1994): 520.

²⁸⁰ *Ibid.*, 519.

²⁸¹ Brenton, "Hopi Foodways: Biocultural Perspectives on Change and Contradiction," 93.

²⁸² *Ibid.*, 132; Kuhnlein, H. V., "Contemporary Hopi Food Intake Patterns," 159.

²⁸³ Brenton, "Hopi Foodways: Biocultural Perspectives on Change and Contradiction," 110; Beaglehole and Beaglehole, "Foods and Their Preparation," 63–70.

²⁸⁴ Brenton, "Hopi Foodways: Biocultural Perspectives on Change and Contradiction," 94, 111.

the Hopi diet was a historical process that included shifts not only in consumption patterns, but also in the production of Hopi foods.

Data collected by researchers to document crop production and agrobiodiversity on Hopi lands over the past hundred-odd years is in many ways incomplete and riddled with complication and questions. Barriers such as language, culture, time, and money prevented each and every researcher from conducting what one might consider a comprehensive assessment of food production and agrobiodiversity on the Hopi mesas. What is left for the 21st-century researcher is an amalgamation of reports, crop surveys and interviews that, together, comprise of a field filled not only of purple corn and black lima beans, but of additional questions that, in many cases, can only be asked and answered by Hopis themselves.²⁸⁵

At the end of the 19th century, Hopis were cultivating around 6,600 acres and in 1936 farmers were still growing food on 6,000 acres. In 1987 only 2,000 acres were under cultivation, a figure that dropped to a mere 1,100 acres by 1991.²⁸⁶ By 2005 only one-third of Hopis identified as farmers.²⁸⁷ Today, most Hopis continue to farm for cultural reasons and social obligations rather than to feed their families. And while the scope and depth of biodiversity in fields and gardens has declined, Hopis are still cultivating nearly half the crop varieties observed and recorded by researchers in the early 20th century. While the number of varieties of cultivars grown by each farmer declined over time, yet some individual farmers continued to grow a wide variety of crops and in doing so maintain a relatively high level of biodiversity in the fields. In

²⁸⁵ For more on the role of crop diversity and associated research challenges, see Stephen B. Brush, *Farmers' Bounty: Locating Crop Diversity in the Contemporary World* (New Haven: Yale University Press, 2004).

²⁸⁶ Brenton, "Hopi Foodways: Biocultural Perspectives on Change and Contradiction," 62.

²⁸⁷ Natwani Coalition, "Current State of Hopi Food and Farming," 2005, 2, <http://www.hopifoundation.org/programs/natwani>.

the 1930s ethnobotanist Alfred Whiting documented 25 varieties of corn, 25 varieties of beans, at least six varieties of melons, three varieties of squash, and multiple types of gourds being dry farmed in Hopi fields.²⁸⁸ By 2013 16 varieties of the corn Whiting documented were still being cultivated, alongside 15 varieties of beans. All of the melons and squash Whiting documented were still being grown, and while some farmers reported growing gourds, it was difficult to discern which varieties, if any, were no longer being cultivated.

Cultural demands for specific crop varieties often shape farmers' choices, effectively constraining diversity in the fields. All of the farmers I spoke with in 2013, for example, grew blue and white corn, primarily because Hopi women use these varieties to prepare traditional foods for social and cultural events throughout the year. While one farmer maintained a personal seed bank of 16 corn varieties, it was more common to hear of crop repertoires that included only 2 or 3 varieties of corn. For many farmers, this shift in biodiversity differs markedly from the fields they tended as children with their fathers, uncles, and grandfathers.

Farmers often spoke of times from their childhood when certain varieties, like Hopi sweet corn, were quite common. A Third Mesa farmer who grew up in the 1940s and now only grows blue and white corn joyfully remembered the cultivation of Hopi sweet corn during his childhood. The sweet corn would usually mature in time for the Home Dance. They would then bake it in pit ovens. "Those were memorable times," he recalled.²⁸⁹ While Hopis still participate in the communal pit roasting of sweet corn, it is common for families to obtain corn from non-Hopi sources. Farmers often mentioned that fewer people are growing Hopi sweet corn than did during their childhood, and some fear that the variety is becoming endangered. As one farmer

²⁸⁸ Whiting, *Ethnobotany of the Hopi*.

²⁸⁹ Hopi man, interview by author, Kykotsmovi, Arizona, November 7, 2013.

explained, “Our sweet corn is going because people just don’t raise it and are running out of seed.”²⁹⁰ Another mentioned that some families travel south to Camp Verde to purchase sweet corn, possibly due to colder temperatures in the spring preventing the early planting necessary for maturation by the Home Dance.²⁹¹

Many farmers observed that most Hopis are growing only blue and white corn, and expressed concern about the erosion of biodiversity in their fields and the impact of genetic erosion on cultural practices and culinary diversity. “We’ve lost a lot of our varieties,” one Second Mesa farmer told me on a summer afternoon; “we used to have like five or six different types of blue corn.” Each variety, he explained, has a specific cultural use and many varieties are not being grown anymore. “It’s kind of disheartening,” he lamented. When these varieties are no longer grown, he explained, Hopis will be unable to cook traditional foods. “We have forty dishes you make corn with,” he said. “And so if you don’t have corn, how are you gonna cook those dishes?” Substituting store-bought corn isn’t an option, he said, because the dishes won’t turn out the same. “So what do you do?” he asked me. “Your culture disappears on you.”²⁹²

This farmer links biodiversity in the fields to the perpetuation of Hopi traditional meals, and in doing so illuminates the intimate relationship between production and consumption. His words entwine cultural survival with the preservation of biodiversity and culinary practices, inspiring us to think deeply about these connections in a world where most of us are disconnected from the cultural and ecological processes that nourish our bodies. For the farmers I spoke with, cultural survival is dependent on the perpetuation of agricultural and culinary practices through the generational transmission of knowledge, intimately tied to the continued

²⁹⁰ Hopi man, interview by author, Kykotsmovi, Arizona, June 5, 2013.

²⁹¹ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

²⁹² Hopi man, interview by author, Kykotsmovi, Arizona, June 5, 2013.

resilience of the people and plants that have thrived in their high desert environment for over a thousand years.

While the traditionally male spaces of dry farmed fields continue to be sites of knowledge transmission and biological conservation, so too do the remaining terrace gardens that Hopi women have tended for generations. When Alfred Whiting and Volney Jones visited terrace gardens in several Hopi villages during the mid-1930s they saw plots filled with chili, onion, plants like amaranth and saffron used by women to dye piiki batter red and yellow, and numerous other garden vegetables. By the end of the 20th century, many of these irrigated gardens were no longer being used and gardens planted beside one's home had become more common as domestic water could be used to nourish the plants. In the terrace gardens still in use, a shift in biodiversity had occurred. Most of the plants being cultivated were no longer Hopi varieties, but grown from seeds and seedlings purchased from catalogs, traded with others, or purchased in big box stores like Wal-Mart and Home Depot in border towns such as Flagstaff, Arizona.

One of the most significant changes in Hopi gardens is the replacement of Hopi chilies with hybrid varieties purchased in nurseries. While non-Hopi chili varieties were present in some Hopi gardens in the 1930s, Hopi varieties still comprised the majority of plants. By 1989 only 7% of Hopis surveyed were growing Hopi chilies, while 68% of respondents reported cultivating commercial varieties. One farmer from Hotevilla expressed regret in 2013 for the loss of older varieties and planting methods in his village's terrace gardens. Over the years, he has noticed women are no longer planting chile from seed, but rather using transplants purchased off the reservation. This is quite different than the methods he used with his mother in the Hotevilla terrace gardens as a child. He used to gather a particular type of sand from below the mesa,

carrying buckets of it back up to the village. His mother would then use it to propagate Hopi chile seeds in the garden terraces. Once they grew to a certain height, she'd transplant them. He expressed that he wanted to see a revival of old planting methods like those he helped his mother with in the Hotevilla gardens during the 1960s. When I asked him if he knew of anyone who still has the old Hopi chili seeds, he replied:

If there is, it's gonna be amazing because I would say within the last twenty years everything has been overrun by seeds from outside of Hopi here at Hotevilla.... Like I said, a lot of it is just not from seed. Nowadays it's already a transplanted item that's bought over at a nursery store or maybe Home Depot, something like that, brought out here and then put back into the garden. They'll flourish but the part is that old technique of them actually saving the seedpod, the chile pods from the year before, and then planting it like that. I don't see that very often anymore.²⁹³

Another farmer from Hotevilla shared similar observations of women using transplants instead of growing chili from local seed, but knows of at least one woman who still saves her seed each year. "My grandfather's sister does that to this day," he told me during our interview.²⁹⁴

The replacement of Hopi chilies with commercial varieties is one example of how the genetic makeup of Hopi fields and gardens changed over the course of the 20th century. As early as the 1960s Hopis were utilizing seed catalogs to order melon seeds from Colorado, grapes from Nebraska, and muskmelon seeds from Parker, Arizona, while purchasing seeds of cassava and pinto beans at local trading posts.²⁹⁵ This pattern is reflective of both the Hopi willingness to try

²⁹³ Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

²⁹⁴ Hopi man, interview by author, Kykotsmovi, Arizona, July 31, 2013.

²⁹⁵ 1964 Crop Survey, Alfred F. Whiting Collection, MS 25, Northern Arizona University Cline Library, Flagstaff, Arizona.

new crops as well as an influx of cash into the reservation economy through wage labor to allow farmers to purchase seeds rather than simply save and trade with their fellow farmers.

This influx of non-Hopi varieties continued throughout the 20th century and by the beginning of the 21st century a new threat to biodiversity of Hopi crops arrived on the mesas. As more and more families found themselves in need to corn to fulfill social obligations, outside vendors began making their way to the reservation, claiming to have “Hopi” corn grown in eastern Colorado or the Rio Grande Pueblos. One of these vendors, a man by the name of Bill Baker who calls himself “The Corn Man” travels throughout the Southwest and into Indian Country each year to sell “Hopi” corn to Hopis in need. His presence demonstrates a gap between supply and demand in terms of traditional food in the community, as one woman who spoke with the Corn Man explained.

We need that help back from the guys, like the farming. Yesterday this guy was at the Cultural Center. He was from Colorado. He had this huge horse trailer. He had come out here because there was two ladies, he said, he didn't tell us who they were, but that they needed a truckload each of the blue and white corn... I don't know where his farm is, but he had this whole horse trailer full of blue corn and white corn that he was to sell to two ladies. And so that was just like a real shock to me. Again, see, we need it. The guys need to become strong and become men again or become farmers again. We've lost them somewhere. But it's hard to get guys to really get into this stuff, into farming.²⁹⁶

While most who purchase The Corn Man's crops use them to prepare traditional foods, there are some who plant the kernels of corn in their fields next to traditional varieties. Given the fact that The Corn Man's corn are raised beside neighbors growing genetically modified corn, the planting of this corn is a potential threat to the genetic diversity of Hopi corn and to Hopi

²⁹⁶ Hopi woman, interview by Tai Johnson, Bacavi, Arizona, August 17, 2007, Hopi Cultural Preservation Office Archives, Kykotsmovi, Arizona.

food security. In 2013 the Hopi Cultural Preservation Office temporarily halted The Corn Man's operations, in part igniting a multifaceted conversation among Hopis concerning the future security of their food in both genetic and cultural terms. Most Hopis I spoke with felt the need to protect Hopi crops from contamination through cross-pollination with The Corn Man's corn, corn purchased from New Mexico, or other non-Hopi varieties.

It's really becoming evident in the last three years - the introduction of outside seeds to Hopi and not valuing and realizing that our seed is unique to this area and how we may have lost some of those traits already because of the cross-pollination issues. I remember probably about ten years ago, maybe eight years ago from today, seeing people coming in from the outside to sell corn, which to me, I guess, was an indicator that people maybe weren't farming or weren't getting as much and of course outsiders seeing an opportunity to have a market here... You can argue a lot of different levels on this but one issue is if you're gonna buy it, then use it to eat... But that introduction is starting, I think, to be lead to, people using that to plant. And it was innocent, I think, early on, 'cause we didn't understand the implications but today that's one of our largest issues is trying to save our heritage seed and realizing we might have already lost some of that.²⁹⁷

This Hopi woman's observations speak to broader issues of food security on the mesas, including increasing pressure on fewer farmers to produce enough crops to ensure their daughters, wives, mothers, and nieces can fulfill their cultural obligations with traditional food. In a survey of one hundred female headed households on the Hopi reservation conducted in 2006 over half of the women said they purchased traditional food, and 35% stated that purchasing traditional food was the second most important way of obtaining it.²⁹⁸ The purchase of traditional foods was not a common occurrence until recent years, and is reflective of the dietary transition experienced by the Hopi people over the course of the twentieth century.

²⁹⁷ Hopi woman, interview by author, Kykotsmovi, Arizona, July 31, 2013.

²⁹⁸ Cornelia B. Flora, et al., "Understanding Access to and Use of Traditional Foods by Hopi Female Headed Households to Increase Food Security," December 6, 2006.

Shifts in Hopi resources including labor, plants, and animals facilitated a move away from the regular consumption of traditional foods to one based on foods purchased in grocery stores or procured through state and federal programs. By the beginning of the 21st century the Hopi food system had been turned on its head. Rates of diabetes and obesity had skyrocketed, with at least 40% of patients treated at the Hopi Health Care Center having been diagnosed with diabetes, a rate nearly double that of Indian Health Service estimates in the early 1990s.²⁹⁹ By 2005 76% of Hopis were either overweight or obese.³⁰⁰ That same year Hopis spent nearly seven million dollars to transport food to the reservation, with individual shoppers spending an additional \$2,000 each year in food transportation costs.³⁰¹

When considered within the context of the World Health Organization's (WHO) three pillars of food security, the current Hopi food system is unstable.³⁰² While sufficient quantities of food are available to Hopi families on a regular basis, the demand for traditional food outweighs the supply. The genetic erosion of Hopi agrobiodiversity also influences availability of and access to traditional foods. Food security cannot, however, be accurately analyzed without the examination of a resource critical to agricultural success – water. The role of water in Hopi agriculture and the development of water resources is crucial to understanding the broader contours of agroecological change on the Hopi Indian Reservation since the 1930s.

²⁹⁹ Jamie Keith, Health Promotion and Disease Prevention: Hopi Health Care Center, telephone conversation with author, September 10, 2007; Brenton, "Hopi Foodways: Biocultural Perspectives on Change and Contradiction," 153.

³⁰⁰ "Current State of Hopi Food and Farming," 2005, 2.

³⁰¹ *Ibid.*, 1.

³⁰² The World Health Organization sees food security as being built on three pillars – food availability, food access, and food use. See "WHO | Food Security," *WHO*, accessed February 28, 2016, <http://www.who.int/trade/glossary/story028/en/>.

CHAPTER THREE WATER

On a cool spring morning in 1932 Ernest Beaglehole watched as the sun rose over Second Mesa, illuminating the sky as it gently enveloped the Hopi villages below. Around seven o'clock he heard the crier chief announce that it was time for the women and girls to begin preparing food. For today was a day of community importance – the annual cleaning of a spring. Several hours later the crier announced that the village's men should gather at the spring and that the women must begin baking the somi'viki, a special dish often prepared for men engaged in communal activities. As the women began making the soft, sweet blue corn dough that would fill cornhusks they soaked morning, village leaders made prayer offerings at the spring and the work commenced. The strongest of the men dug out and carried away the sand that the season's high winds had blown into the spring's terraces. Older men carefully hoed weeds while members of the Water Clan used their hands to dig out the black mud at the spring's bottom. Children passed containers of the mud hand-to-hand down a line until the last child emptied it far away from the spring. As they worked, the men and children laughed and gossiped, enlivening their labor with an occasional joke. Once the spring was cleared of mud, the Water Clan placed offerings along with prayers for rain, signaling the end of the men's work and all joined in the feast prepared by the women and girls.³⁰³

The cleaning of this spring as witnessed by Ernest Beaglehole in the early 1930s is but a single memory of an outsider, but vibrantly illustrates the deep connections between Hopis and the water sources that have physically and spiritually sustained them since their arrival on Black

³⁰³ Ernest Beaglehole and Pearl Beaglehole, *Notes on Hopi Economic Life* (New Haven; London: Published for the Section of Anthropology, Department of the Social Sciences, Yale University, by the Yale University Press; H. Milford, Oxford University Press, 1937), 30.

Mesa over a thousand years ago. For generations Hopis remained dependent on the ancestral springs that surrounded their villages. Springs not only produced water necessary for drinking and cooking, but also provided villages with perennial sources of irrigation. When rains failed to fall on dry farmed fields of corn, these waters irrigated fields and terrace gardens, serving as a sort of insurance policy against drought-induced famine. Dependence on these water sources fostered the development of community structures, institutions, and practices that ensured these sacred spaces were monitored, maintained, and respected as the periodic cleaning of springs demonstrates. This type of communal cooperation, much like the work parties organized to plant a farmer's fields, continued well into the first half of the 20th century.

By 1970, a whirlwind of social and economic development projects had swept across Black Mesa, irreversibly changing the course of Hopi water and its relationship to the people whose survival remains intertwined with its own. Wells were drilled, washes were dammed, and Hopi groundwater flowed through pipelines into houses, schools, and to coal-fired power plants hundreds of miles away. Some Hopis supported these changes, while others opposed them. And as water flowed in new ways, new challenges emerged. Groundwater sources began to dwindle, causing many Hopis to question spikes in both domestic and industrial usage. Pollutants including arsenic, petroleum, and uranium made their way into Hopi groundwater, threatening human and environmental health. In less than two generations, the world in which anthropologist Ernest Beaglehole observed a communal act of traditional water management had been radically altered.

When Ernest Beaglehole first visited the Hopi mesas in the early 1930s water was a scarce and highly revered resource, conservation and respect remained central tenets of Hopi hydrology in both thought and practice. Local springs supplied the bulk of domestic water. Hopis

supplemented this supply by harvesting rainwater in catchment basins, constructed rock tanks, and cisterns. Naturally occurring and sometimes enlarged holes in bare rock surfaces filled with rainfall as connected tunnels carved out of rock served as collecting channels.³⁰⁴ Hopi women and children spent hours each day transporting water up the steep mesas from the springs below, as few Hopi houses were equipped with domestic water infrastructure until much later in the century. Springs not only supplied water for drinking, livestock, cooking, and washing, they also served as a reliable source of water for terraced gardens on each mesa and for irrigated fields in the village of Moenkopi. Seepage from springs also sustained peach groves that grew in clusters on the slopes beneath them.³⁰⁵

Springs were key to Hopi survival in the 1930s and have continued to occupy a central place in Hopi ontology through the present. In the words of former Tribal Chairman Vernon Masayesva and anthropologist Peter Whiteley,

The ways in which the Hopi get and use water are a major part of identity, religious beliefs, ritual practices, and daily engagements and concerns. Much of the complex Hopi religious system is devoted, in one way or another, to securing necessary blessings of water – in the form of rainfall, snow, spring replenishment, and so forth – to sustain living beings, whether humans, animals, or plants.³⁰⁶

In short, springs are key in Hopi social life, cultural values, and conceptualization of the landscape, all

³⁰⁴ John T. Hack, “The Changing Physical Environment of the Hopi Indians of Arizona” (Cambridge: Peabody Museum, 1942).

³⁰⁵ Forde, “Hopi Agriculture and Land Ownership,” 366.

³⁰⁶ Peter Whiteley and Vernon Masayesva, “The Use and Abuse of Aquifers: Can the Hopi Indians Survive Multinational Mining?” in *Water, Culture, and Power: Local Struggles in a Global Context*, ed. John Donahue (Washington, D.C.: Island Press, 1998), 12.

of which form the ground of deeper religious thought and action.³⁰⁷

Hopi ontology, then, is rooted in hydrology. As such, water is the source of both spiritual and physical survival. This way of understanding the world sometimes conflicted with outside efforts to document, understand, and harness Hopi water over the course of the 20th century. And as we have seen in earlier chapters, the roles Hopis played in these developments and their perspectives on Hopi resources were not uniform.

Federally sponsored documentation of water resources on the Hopi Indian Reservation during the 20th century began in the late spring of 1909 when three employees of the U.S. Geologic Survey (USGS) embarked on a brief journey to the Hopi and Navajo Indian Reservations to procure data on the hydrological and mineral resources of Black Mesa. On a bright and windy May morning, three men climbed into a wagon near the Santa Fe Railway stop of Sunshine, Arizona. Under the guidance of Indian Office irrigation engineer H.F. Robinson, the group, which also included Herbert E. Gregory and M.R. Campbell, made their way through the Navajo Indian Reservation from Canyon Diablo to Leupp. Before continuing on to Hopiland, the group of engineers and geologists stopped to view the Black Falls of the Little Colorado. From there they traveled the long, dusty road to the Hopi village of Oraibi. After a brief respite, the team of hired horses pulled the wagon across Third Mesa and on to Tuba City where they traveled up the Moenkopi Wash to Blue Canyon before heading back to Oraibi. The group then

³⁰⁷ Ibid., 18.

traveled eastward through Mishongnovi, Keams Canyon, and Ganado where they finally dispersed.³⁰⁸

Herbert Gregory, however, decided to stay on through September to collect data on Black Mesa's coal and water resources. Gregory, who was a professor of physiography at Yale, traipsed around Black Mesa over the next several months, gathering information for what would become a multi-year exploration of the region. His preliminary findings facilitated several more seasons of fieldwork, which would result in the first scientific publications documenting Hopi water and mineral resources in detail. Over the next four summers Gregory led a group of engineers and geologists from the USGS and the U.S. Office of Indian Affairs as they performed a "geographic and hydrographic reconnaissance" of the Hopi and Navajo Indian reservations. Between 1910 and 1913 Gregory and his associates documented surface water and groundwater resources including perennial and ephemeral streams, floodwaters, springs, and seeps. They also observed and quantified existing development and use of these waters by Hopis and Navajos such as drilled wells, developed springs, the storage of surface water for livestock, the utilization of surface water for federal projects and the use floodwaters and groundwater for irrigated agriculture.³⁰⁹

In addition to mapping and quantifying water resources, Gregory's team also worked with the Irrigation Division of the U.S. Office of Indian Affairs to drill over twenty wells in the washes running through the Hopi Indian Reservation—the federal government's first attempt at extensive water development on Hopi lands. Gregory viewed such development as the key to the

³⁰⁸ Herbert E. Gregory, "The Navajo Country--a Geographic and Hydrographic Reconnaissance of Parts of Arizona, New Mexico and Utah" (United States Geological Survey, 1916).

³⁰⁹ Ibid.

region's future – a future, he saw, that depended “fundamentally on the solution of one problem – the water supply.”³¹⁰ Referring to the Hopi as “an almost extinct race” that was at as “uncivilized” as it was “heroic,” Gregory saw his role as a geologist on Black Mesa “to improve the condition of this long-neglected but capable race, to render their life more intelligently wholesome by applying scientific knowledge.” Such work, he admonished, gave him “pleasure in no degree less than that obtained by the study of the interesting geologic problems” the region afforded him.³¹¹

The idea that Western science and technologies were key to economic development on Black Mesa is reflected in his team's recommendations. The group of federal engineers and geologists agreed that livestock improvement, and the water development it required, could help solve economic problems on the Hopi and Navajo reservations. This belief would trickle down through the decades that followed Gregory's early 20th-century reconnaissance, forming critical components of economic and water development projects on Black Mesa during the 1930s and 1940s. Such a policy, in Gregory's own words, was necessary in creating a region that was “useful.” He advocated for a future that included the development of water resources for livestock and the improvement of these herds and flocks through policy-driven breeding programs. As he wrote in 1916,

The future of the Navajo and Hopi reservations is bound, up with its development as a stock country rather than with agriculture. Irrigation on a moderate scale is feasible along the permanent watercourses, and small parcels of land may be watered by utilizing springs, building dams, and constructing wells at many localities; but a policy directed toward improving breeds, conserving

³¹⁰ Ibid., 10.

³¹¹ Ibid., 9.

grazing, introducing new forage plants, and developing water for herds and flocks is most likely to insure the highest usefulness for the region.³¹²

By the 1930s, the federal government was engaged in multiple water development projects on the Hopi Indian reservation, drilling wells to support livestock and damming minor streams flowing through sandy washes to create storage for water to be consumed by Hopi sheep, cattle, and goats.³¹³ Federal agencies also constructed a series of irrigation projects that attempted to harness both ground and surface water flows. While the majority of these projects were new, one focused on improving existing irrigation infrastructure for Hopi farmers in the village of Moenkopi – the only Hopi village where fields of corn are irrigated instead of dry farmed. In 1903 the federal government purchased land near Reservoir Canyon, 13 miles west of the Hopi reservation, from Mormon settlers. Years earlier, Mormon farmers constructed three dams in Reservoir Canyon in an attempt to store water flowing from the canyon’s springs, springs with which Hopi farmers from the village of Moenkopi irrigated their crops.³¹⁴ Two of these dams were raised in 1908 and due to the threat of drifting sand choking the channel agents built a stone culvert that they later extended with corrugated pipe. In 1937 workers constructed a new feeder canal and by the mid-1940s Hopis in the village of Moenkopi were irrigating at least

³¹² Ibid., 77.

³¹³ Hack, “The Changing Physical Environment of the Hopi Indians of Arizona,” 1942.

³¹⁴ Thomas E. Sheridan provides a concise, yet detailed history of Mormon agrarian settlements and irrigation projects in the Little Colorado watershed during the later 19th and early 20th centuries. See Thomas E. Sheridan, *Arizona: A History*, (Tucson: University of Arizona Press, 1995), 187-198.

300 acres.³¹⁵ Irrigation water from Pasture Canyon Reservoir remains critical to the success of Moenkopi farmers to this day.³¹⁶

Throughout the 1930s and 1940s federal agencies developed new water sources on the Hopi Indian Reservation. Agencies including the Soil Conservation Service, Indian Office, and United States Geological Survey often worked together cooperatively. For example, between 1934 and 1940 the Soil Conservation Service aided the Indian Office in the development of regional groundwater supplies.³¹⁷

Several of these projects were aimed at developing groundwater supplies on the Hopi Indian Reservation to be used by Navajos in irrigated farming.³¹⁸ The first of these ventures was the Hardrock Project, originally named the Lower Oraibi Wash Project, which was constructed about twelve miles northeast of the Hopi village of Oraibi by the Navajo Service on the Oraibi Wash. Made possible with federal New Deal funding through the Public Works Administration, the project diverted floodwater flows from the Oraibi wash to seventy acres that government workers leveled and fenced in with the help of a masonry diversion dam, silt trap, canal, and flume. Administrators estimated that about 300 acres could be irrigated with the redirected waters, but “no use was made of it” and in 1942 the Navajo Service handed the project over to

³¹⁵ “Long Range Program for the Hopi Tribe, Arizona, March 1944,” 19.

³¹⁶ Hopi woman, interview by author, Moenkopi, Arizona, November 7, 2013; Hopi woman, interview by author, Kykotsmovi, Arizona, June 5, 2013.

³¹⁷ Leonard Cameron Halpenny and John William Harshbarger, “Preliminary Report on the Ground-Water Resources of the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah” (Holbrook, Arizona: United States Geological Survey, August 1951), <http://pubs.er.usgs.gov/publication/ofr51113>.

³¹⁸ While little has been written on the Soil Conservation Service’s work on the Hopi Indian Reservation during this period, historians Richard White and Marsha Weisiger discuss the agency’s programs on the Navajo Indian Reservation. For an examination of the Soil Conservation Service’s work in the Southwest more broadly and on the Navajo Indian Reservation in particular, see White, *The Roots of Dependency*; Weisiger, *Dreaming of Sheep in Navajo Country*; Helms et al., *Readings in the History of the Soil Conservation Service*.

the Hopis. When it changed into Hopi hands, the Hardrock Project was in desperate need of repairs and very little irrigated farming was possible in its present state.³¹⁹

Constructed in 1934, the Begashibito Project was located along Cow Springs Wash approximately forty miles east of Tuba City within the boundaries of the Hopi Indian Reservation. There the lower of the canyon ends in a closed basin that once transformed into a natural lake when there was sufficient runoff from rain or snow. In 1934 federal officials constructed four redwood pipelines nearly two thousand feet long that effectively drained the lake to irrigate about 140 acres. A lack of water, however, constrained the project's success and within five years administrators recorded "no water available" in their annual records.³²⁰

Despite the fact that there was "no water available" at the Begashibito Project due to a lack of precipitation in 1939, Navajo Service officials continued along with the construction of another irrigation project – this one in Jeddito Wash. Constructed by the Navajo Service in 1939, the Jeddito Project differed from other water development projects during this period in that it was intended for utilization by both Hopis and Navajos. Located approximately 50 miles north of Winslow, the project consisted of a concrete diversion dam 95 feet in length and 7.5 feet high with radial sluice and turnout gates at either end. Navajos were to farm on the left side of the wash, with Hopis utilizing the right. On each side of the wash were canals through which the

³¹⁹ Ibid.; Lowery and Ladd, "1944 Annual Report of Extension Work, Hopi Indian Reservation."

³²⁰ By 1955 drought conditions prompted officials and the Navajos farming there to at least temporarily abandon the project. See U.S. Department of the Interior, Bureau of Indian Affairs, Gallup Area Office, "Factual Data in Support of Claims for Indians and Indian Tribes to Uses of Water in the Lower Colorado River Basin of the Colorado River in the States of Arizona and California: Volume XV-Hopi Indian Reservation, Arizona," September 1955, 9–11, RG 75 Records of the Bureau of Indian Affairs, Division of Management Services, Factual Data on Indian Reservations of the Lower Colorado River Basin, 1922-1957, Vol. 14 to Vol. 19, Box 4, E1415, National Archives I.

diverted floodwaters were channeled. The Hopi main canal was one-half mile in length with two main branches approximately five-eighths of a mile each. The Navajo Service subjugated, bordered, fenced, and divided the land into 28 lots, making a total of 57 acres irrigable, and in 1941 constructed a flood protection dike.³²¹

The Jeddito Project created a commercial space for the cultivation of alfalfa to support a supplemental livestock-feeding enterprise being promoted by the Bureau of Indian Affairs. By 1944 the Polacca Stockgrowers Association was operating the Jeddito Project, raising supplemental feed for First Mesa sires, an enterprise that went hand-in-hand with federal stock reduction programs and the associated procurement of sheep and cattle suitable for regional, national, and global markets. As Bureau officials put it in 1944,

The procurement of better sires for the general improvement of Hopi livestock can have but little justification if these expensive animals are permitted to fend for themselves during the winter months. This has been the prevalent practice heretofore and it is reflected in both the quality and condition of sires following the usual winter. Therefore, our program contemplates the utilization of every feasible productive site for the growing of supplemental feed.³²²

In fact, federal agents proposed an even broader usurping of Hopi floodwaters for the purpose of raising commercial livestock feed, suggesting that 300 acres of land on the Oraibi Wash, connected to the earlier Hardrock Project, be planted in alfalfa and irrigated using a series of dikes.³²³ Despite the ongoing cycle of erosion, floodwater runoff that traveled through arroyos

³²¹ “Long Range Program for the Hopi Tribe, Arizona, March 1944,” 19.

³²² *Ibid.*, xxxiii.

³²³ *Ibid.*

and washes after heavy rainstorms, fanning out over alluvial flatlands remained a critical factor in the successful cultivation of Hopi corn as late as the 1940s.³²⁴ The diversion of ephemeral surface waters by federal projects was likely a contributing factor to a decline in floodwater farming that began in the late nineteenth century as arroyo cutting “reduced the cultivable value of much land that was formerly subject to abundant natural irrigation.”³²⁵

While the Hardrock, Begashibito, and Jeddito projects harnessed floodwaters traditionally used by Hopi farmers, other federal water development projects utilized both ground and surface water. In 1944 alone federal agents constructed seventy-two surface water retention structures with funds from the Agricultural Adjustment Act program, including farm dikes, water spreaders, earthen reservoirs for stock water and one “very large” earthen dam that diverted water from both the Polacca and Wepo Washes. Once diverted, this surface water was spread “over a large valley that runs parallel with the Polacca wash for a distance of some seven or eight miles,” and would, “eventually sink into the land not far from the springs that furnish water for the Phillips Farm irrigation project.”³²⁶

The Phillips Farms Project, by contrast, primarily utilized Hopi groundwater. Located twenty-four miles southwest of the village of Polacca, the Phillips Farms Project was constructed on Polacca Wash in 1940. Originally intended for the permanent resettlement of eighteen Hopi families that would farm lands adjacent to the wash, the Phillips Farms irrigation infrastructure included a masonry dam with a spillway 145 feet in length and three radial gates. A gasoline-powered pump powered lifted waters originating from the springs rising in the bed of Polacca

³²⁴ Guy R. Stewart, “Conservation in Pueblo Agriculture: II. Present-Day Flood Water Irrigation,” *The Scientific Monthly* 51, no. 4 (October 1940): 329.

³²⁵ Forde, “Hopi Agriculture and Land Ownership.”

³²⁶ Lowery and Ladd, “1944 Annual Report of Extension Work, Hopi Indian Reservation.”

Wash fifty-eight feet above the source point to the bench above the wash where they made their way through 220 feet of eight-inch steel pipe. The spring water was then discharged into a concrete basin on the left bank of the wash before making its final journey down a 2200-foot-long irrigation canal and onto forty-three acres government officials subjugated in 1939 and 1941.³²⁷

While Phillips Farms' purpose was to produce crops, the majority of water development projects on the Hopi Indian Reservation during the 1930s and 1940s, as noted in chapter one, served not Hopi farmers, but Hopi ranchers and their livestock. Hopi husbandry practices were undergoing a capitalist transition at this time, and water development projects throughout Hopi lands assured that sheep, cattle, and the handful of goats that remained after forced livestock reduction would graze in a dispersed manner facilitated by the deliberate spacing of developed water sources across the range. By the end of 1938, eighteen windmills stood built beside numerous natural springs; the windmills and their large storage tanks had "been developed to facilitate better range use and soil conservation."³²⁸ And by 1944 the U.S. government had built or developed 173 water supply units on the Hopi Reservation including drilled wells, dug wells, springs, and charcos, and windmills, all of which were managed by a Foreman of Water Development and maintained through an annual federal appropriation of \$7,500.³²⁹

Wells were developed on the Hopi Indian Reservation between 1942 and 1948 with the assistance of the Technical Coordination Branch of the U.S. Geological Survey, which aided

³²⁷ "Long Range Program for the Hopi Tribe, Arizona, March 1944"; Hall and Wilson, "1939 Annual Narrative Summary of Extension Work, Hopi Indian Agency."

³²⁸ Miller and Wilson, "United States Department of the Interior, Office of Indian Affairs, Division of Extension and Industry Annual Report of Extension Workers, Hopi Indian Agency, Keams Canyon, Arizona from January 1, 1938 to December 31, 1938."

³²⁹ "Long Range Program for the Hopi Tribe, Arizona, March 1944," 3.

other agencies in selecting sites suitable for development.³³⁰ In 1946 the United States Bureau of Indian Affairs made a request for technical assistance from USGS citing “groundwater problems” on the Hopi and Navajo Indian Reservations.³³¹ USGS completed site investigations throughout 1946 and 1947, and in January 1948 the agency’s Ground Water Branch began working in the region on a limited scale, “assisting the Indian Office in locating and developing groundwater supplies” in an effort to “alleviate water shortage in several places.”³³²

In October 1950 the Ground Water Branch began a “reconnaissance of the groundwater resources and geology of the Navajo country” at the request of and funded by the United States Office of Indian Affairs. Internally referred to as the Navajo Ground Water Project, the study initially served only two purposes. First, it would “aid the Indian Office currently in locating and developing groundwater supplies for livestock, domestic, and community use,” and second, it would generate “a comprehensive report on the groundwater resources and geology of the region,” which would “serve as a guide to further development and utilization of the available water supply.”³³³ The project was by then under the direction of John Harshbarger, who joined USGS as a geologist in the late 1940s and would go on to make important contributions to the growing field of hydrology and become chair of the Hydrology and Water Resources program at

³³⁰ Halpenny and Harshbarger, “Preliminary Report on the Ground-Water Resources of the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah,” 2.

³³¹ M. E. Cooley, J.W. Harshbarger, J. P. Akers, and W.F. Hardt, “Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a Section on Vegetation” (Washington, D.C.: U.S. Geological Survey, Prepared in cooperation with the Bureau of Indian Affairs and the Navajo Tribe, 1969), A5.

³³² Halpenny and Harshbarger, “Preliminary Report on the Ground-Water Resources of the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah,” 2; Cooley, Harshbarger, Akers, and Hardt, “Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a Section on Vegetation,” A5.

³³³ Halpenny and Harshbarger, “Preliminary Report on the Ground-Water Resources of the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah,” 1.

the University of Arizona.³³⁴ By the late 1950s, the project's principal objectives were expanded to include determining the feasibility of developing groundwater supplies for industrial use.³³⁵

In addition to the scientific study, geologists worked concurrently with the Bureau of Indian Affairs to institute a well development program.³³⁶ Between 1950 and 1955 Survey geologists collected data, and this work continued intermittently from 1956-1960.³³⁷ In 1960 Survey geologists renewed efforts to complete the project and publish the associated reports, which consisted primarily of data collected during the 1950-1955 period.³³⁸ The final report, published in 1969, would serve as the primary scientific source documenting Black Mesa's hydrology and geology until the 1980s.

The 1950s also saw additional development of groundwater resources for Hopi livestock. Between 1954 and 1964 the U.S. Bureau of Indian Affairs operated a range water development program on the Hopi Indian Reservation. After the Bureau conducted a survey of the reservation to determine ranchers' needs, the agency implemented development plans with the assumption that the Hopi Tribe would assume operational and maintenance costs upon completion. The Bureau spent over half a million dollars during the ten-year period for the establishment,

³³⁴ Michael D. Bradley, "John W. Harshbarger: The Founding Father of Hydrology and Water Resources at the University of Arizona | Department of Hydrology and Water Resources," <http://www.hwr.arizona.edu/john-w-harshbarger-founding-father-hydrology-and-water-resources-university-arizona>.

³³⁵ M. E. Cooley, J.W. Harshbarger, J. P. Akers, W.F. Hardt, et al., "Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a Section on Vegetation" (Tucson, Arizona: U.S. Geological Survey, December 1964), 20.

³³⁶ Cooley, Harshbarger, Akers, and Hardt, "Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a Section on Vegetation," A2.

³³⁷ Cooley, Harshbarger, Akers, Hardt, et al., "Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a Section on Vegetation," 36.

³³⁸ Ibid.

operation, and maintenance of 51 wells, 3 catchments, 35 springs, 16 miles of pipeline, and 40 water storage facilities.³³⁹

Hopi responses water development in the 1940s and 1950s are diverse. In the Third Mesa village of Hotevilla, some protested the construction of a windmill, arguing that it was put up without the people's consent. Hopis there were concerned that the windmill would cause the sacred spring below the village to dry up, a source they depended on for both domestic use and to water their terrace gardens. The Superintendent, upon considering the villagers' protests, "put the windmill down."³⁴⁰ By contrast, in the village of Kykotsmovi, some petitioned the Bureau of Indian Affairs for windmills to be constructed in their community. "Windmills," as one Hopi from Kykotsmovi stated in 1955, "are in great demand, well located throughout the grazing area and for domestic use." Such development, he argued, would "help preserve our range and also help produce better stock" through the dispersal of animal movement which was then concentrated due to the limited number of water sources. Domestic development was also desired, he argued. The village's school, he explained, had a limited water supply with only a small reservoir and inadequate pumps. Installing a larger tank and better pumps would not only benefit the school, but also the village as a whole whose inhabitants were then dependent on water from springs he saw as "contaminated."³⁴¹ Similar sentiments were voiced on First Mesa, linking water to human health, sanitation, and Hopi culture. As one man stated,

³³⁹ "Bureau of Indian Affairs Phoenix Area Office Area Director to Associate Commissioner of Indian Affairs James E. Officer," May 25, 1966, RG 75 Records of the Bureau of Indian Affairs, Office of the Associate Commissioner, Office Files of Associate Commissioner James E. Officer, 1959-67. Box 17 - Hopi to Housing. E193A. Folder 2, National Archives I.

³⁴⁰ United States, *Hopi Hearings, July 15-30, 1955*, 50-51.

³⁴¹ *Ibid.*, 188.

Our whole life depends on water, and yet it is very scarce on our reservation. Our health, our children, our cleanliness, our livestock, all are dependent on plenty water supply.³⁴²

These requests for domestic water development were rooted a reality during the 1940s and 1950s wherein domestic water supplies remained largely undeveloped on the Hopi reservation. Between 95 and 100 percent of domestic water at Second Mesa and Hotevilla came from springs in 1944, with many families also relying on surface catchment basins to collect rainwater for household use and consumption.³⁴³ Strategies like this for water collection and conservation continued throughout the next several decades. Many Hopis growing up in the 1950s and 1960s recall the centrality of these practices to daily life on the Hopi mesas. Children in the Second Mesa village of Mishongnovi, for example, spent their afternoons collecting water from catchment basins well into the 1960s, as this rancher and farmer recalls:

Our grandparents would give us buckets and we would all go off the mesa to these water holes. We'd get a bucket of water and take it up to the house until our barrels are full. That was how we used the water and that's how we were so dependent on the rain.³⁴⁴

Catchment basins also retained their use as sites for bathing and doing laundry throughout the 1960s, especially during the monsoon season when bathtub shaped indentations would fill with water.³⁴⁵ Water from rainfall as well as from local springs was used conservatively. Families would bathe once per week, using the same water. Once everyone had

³⁴² Ibid., 365.

³⁴³ "Long Range Program for the Hopi Tribe, Arizona, March 1944," 110.

³⁴⁴ Hopi man, interview by author, Kykotsmovi, Arizona, April 26, 2013.

³⁴⁵ Ibid.

washed away the week's work, the water would then be used for cleaning or even watering the garden.³⁴⁶

This philosophy of conservation remained a central tenet of Hopi thought when widespread development of Hopi groundwater for both domestic and industrial usage began to evolve. On July 31, 1959 President Dwight David Eisenhower signed the Indian Sanitation Facilities Act into law, effectively authorizing the U.S. Public Health Service to utilize federal funds in the design and construction of water, wastewater, and solid waste facilities in American Indian homes. By the early 1960s water was entering Hopi homes in new ways, shifting human relationships to water resources in the process.

In 1964 Hopis living in the First Mesa village of Polacca acquired their water from two wells, two water hydrants, and a windmill storage tank. That year the U.S. Public Health Service allocated \$80,000 for a water and sewage system that included a water pumping and distribution system, a sewage treatment plant, and kitchen sinks and toilets for the village's 250 homes. Hopis could purchase hot water heaters and bathtubs at wholesale rates, and homeowners had to supply their own labor to dig trenches and lay pipe from the main water lines into their homes. The federal government operated the new system for the first year, after which the Hopi Tribal Council took over.³⁴⁷

The entrance of running water and modern plumbing into Hopi homes during the 1960s not only changed the ways in which Hopis interacted with water, but also shifted rates of domestic water usage. New industrial pressures on groundwater accompanied the increase in

³⁴⁶ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013; Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

³⁴⁷ "Hopi Village Seeks to Install Water System," *Amerindian* 12, no. 4 (April 1964): 2.

domestic use, culminating with the development of Hopi and Navajo coal reserves and the construction of a coal slurry pipeline that began operations in the early 1970s.

The federal government's interest in the rich coal deposits that lay beneath Black Mesa can be traced back to the early part of the 20th century with Herbert Gregory's brief reconnaissance of the region's water and mineral resources. As part of the larger U.S. Geological Survey study that was conducted 1909 and 1913, Gregory determined that "coal beds of good quality and workable thickness were present in and around" Black Mesa and that the quality of coal was "equal if not better than that of the coal mined at Gallup."³⁴⁸ In 1948 the agency's Organic Fuels Branch began a "study of the mineral-fuel potential of parts of the Navajo country."³⁴⁹ By the mid-1950s the Bureau of Indian Affairs had completed a study on the feasibility of developing Hopi and Navajo coal, and in 1964 the Navajo Tribal Council signed a lease with Peabody Coal Company, which would become a subsidiary of Kennecott Copper Corporation in 1968.³⁵⁰ This lease gave Peabody the right to mine 25,000 acres of Black Mesa on the Navajo Reservation. The nation's largest coal producer would pay the tribe a mere "25 cents a ton – a higher royalty than had ever been negotiated for coal developed on Indian or public lands – for coal use off the reservation and 20 cents a ton for coal used on the reservation."³⁵¹ The Kayenta mine would be one of two mines extracting Black Mesa coal and would provide

³⁴⁸ M.R. Campbell and Herbert H. Gregory, "The Black Mesa Coal Field," Paper, U.S. Geological Survey Bulletin (Washington, D.C.: GPO, 1911).

³⁴⁹ Cooley, Harshbarger, Akers, and Hardt, "Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a Section on Vegetation," A5.

³⁵⁰ Peabody Coal Company, "Mining Coal on Black Mesa," 1970, 3.

³⁵¹ *Ibid.*, 3.

coal for the Navajo Generating Station near Page, Arizona.³⁵²

On June 6, 1966 Peabody signed another lease to develop coal for the Black Mesa Mine that would fuel the Mohave Generating Station near Laughlin, Nevada. The lease, signed by both the Hopi Tribe and the Navajo Tribe, gave Peabody permission to strip mine an additional 40,000 acres of Black Mesa in the Joint Use Area of the Hopi and Navajo Indian Reservations.³⁵³ According to Peabody, each tribe was to receive “half the royalties and other payments on a scale similar to the earlier Navajo lease,” as well as “\$6.67 for each acre foot of water pumped from the leased area.”³⁵⁴ Of this \$6.67, Peabody paid the Navajo Tribe \$5.00 an acre-foot, while the Hopi Tribe earned only \$1.67 for each acre-foot of water used in mining operations.³⁵⁵ Together the Black Mesa and Kayenta mines would create the largest strip-mining complex in the world at the time.³⁵⁶

³⁵² For more on the history and controversy of coal development on the Colorado Plateau, see Wilkinson, *Fire on the Plateau*; Andrew Needham, *Power Lines: Phoenix and the Making of the Modern Southwest*, 2014; Richard O. Clemmer, “Black Mesa and the Hopi,” in *Native Americans and Energy Development*, by Joseph G. Jorgensen et al. (Cambridge, Massachusetts: Anthropology Resource Center, 1978), 17–34; Daniel Higgins, *The Black Mesa Case Study: A Postaudit and Pathology of Coal-Energy Groundwater Exploitation in the Hopi and Dine Lands, 1968-2008* (Tucson: University of Arizona, 2010).

³⁵³ Clemmer, *Roads in the Sky*, 215.

³⁵⁴ Peabody Coal Company, “Mining Coal on Black Mesa,” 3.

³⁵⁵ Clemmer, *Roads in the Sky*, 217.

³⁵⁶ The development of tribal natural resources is complex and has affected American Indians throughout the United States in diverse ways. For comparative examples, see Donald Lee Fixico, *The Invasion of Indian Country in the Twentieth Century: American Capitalism and Tribal Natural Resources* (Boulder: University Press of Colorado, 2012); Saleem H. Ali, *Mining, the Environment, and Indigenous Development Conflicts* (Tucson: University of Arizona Press, 2009); Kathleen P. Chamberlain, *Under Sacred Ground: A History of Navajo Oil, 1922-1982* (S.I.: University of New Mexico Press, 2008); Benedict J. Colombi, “Dammed in Region Six: The Nez Perce Tribe, Agricultural Development, and the Inequality of Scale,” *American Indian Quarterly* 29, no. 3/4 (July 2005): 560–89; David H. DeJong, *Stealing the Gila: The Pima Agricultural Economy and Water Deprivation, 1848-1921* (Tucson: University of Arizona Press, 2009); Steven M. Karr, “‘Water We Believed Could Never Belong to Anyone’: The San Luis Rey River and the Pala Indians of Southern California,” *American Indian Quarterly* 24, no. 3

The two mines and the coal-fired power plants they fueled were part of a much larger development project in which indigenous water and coal provided power for the rapidly growing metropolitan areas of Los Angeles, San Diego, Las Vegas, Albuquerque, Tucson, and Phoenix. In 1964 Western Energy Supply and Transmission Associates (WEST), a coalition including “all of the public and private utilities in Southern California that own electric generation properties,” and almost “all such utilities in the rest of the Colorado Basin,” formed.³⁵⁷ Its members included ten Southwest investor-owned utilities and the group planned on spending \$10.5 billion over the next two decades to generate over twice the amount of energy WEST’s members either planned to build or currently had the capacity to generate.³⁵⁸ WEST’s purpose was “to assist its members to obtain efficient and economical new supplies of electric energy,” and by 1965 the group was already planning three coal-fired power plants—a 3,000,000 kw plant near Glen Canyon Dam on Utah’s Kaiporawits Plateau, a 1,500,000 kw plant above Davis Dam on Nevada’s Lake Mohave, and another 1,500,000 kw plant in the Four Corners area.³⁵⁹ These power plants were only one step toward what Los Angeles Department of Water and Power’s James Mulloy termed “the Grand Plan” - a network of mines, coal-fired power plants, hydroelectric plants, nuclear plants, and transmission lines that would “produce more than three times as much power as

(July 2000): 381–99; Byron E. Pearson, “‘We Have Almost Forgotten How to Hope’: The Hualapai, the Navajo, and the Fight for the Central Arizona Project, 1944-1968,” *The Western Historical Quarterly* 31, no. 3 (October 2000): 297–316; Paul C. Rosier, “Searching for Salvation and Sovereignty: Blackfeet Oil Leasing and the Reconstruction of the Tribe,” in *Native Pathways: American Indian Culture and Economic Development in the Twentieth Century*, ed. Brian C. Hosmer, Colleen O’Neill, and Donald L. Fixico (Boulder: University Press of Colorado, 2004), 27–51; Michelle Steen-Adams, Nancy Langston, and David Mladenoff, “Logging the Great Lakes Indian Reservations: The Case of the Bad River Band of Ojibwe,” *American Indian Culture and Research Journal* 34, no. 1 (January 2010): 41–66.

³⁵⁷ Charles F. Luce to Stewart L. Udall, “Negotiations with WEST and Others,” February 26, 1965, Stewart L. Udall Papers, University of Arizona Special Collections.

³⁵⁸ For more on the history of WEST, see Needham, *Power Lines*, 171–182.

³⁵⁹ Luce to Udall, “Negotiations with WEST and Others.”

TVA, 17 times as much as the Aswan Dam project in Egypt, and eight times as much as the Soviet Union's largest power project."³⁶⁰ As historian Andrew Needham argues, WEST's formation "intensified energy development on the Colorado Plateau and the Navajo Nation," both of which would become, "the center of power production for a growing metropolitan Southwest."³⁶¹

Before the Hopi Tribe had even signed a mining lease with Peabody, the federal government promised Hopi water and coal to this group of private and public utilities. In the fall of 1965 Secretary of the Interior Stewart Udall announced the largest coal supply letter of intent agreement ever negotiated in the United States. Under an agreement between utility giant Southern California Edison and Peabody Coal, Udall announced that Black Mesa coal would be transported by either a slurry pipeline or by rail to a power plant site in Nevada.³⁶² Located on the Colorado River below Davis Dam, the Mohave Generating Station would play a critical role in WEST's regional power plan by producing enough electricity to serve at least 2,000 people. Southern California Edison planned to receive half of Mohave's output, with the rest going to the Los Angeles Department of Water and Power, Arizona's Salt River Project, and other southwest utilities.³⁶³

³⁶⁰ Wilkinson, *Fire on the Plateau*.

³⁶¹ Needham, *Power Lines*, 174.

³⁶² Office of the Secretary of the Interior, "Agreement to Utilize Navajo, Hopi Coal Reserves Announced by Secretary of the Interior," September 29, 1965, Department of the Interior, 1963-1969: Box 34, Folder 2: Indian Affairs - News 7/65-6/66, Lyndon Baines Johnson Presidential Library.

³⁶³ *Ibid.*; For a broader regional perspective on these developments in the Southwest, see Needham, *Power Lines*; For a comparative example of energy development in the Northwest, Paul W Hirt, *The Wired Northwest: The History of Electric Power, 1870s-1970s* (Lawrence: University of Kansas Press, 2012).

The following April Udall announced that an agreement had been reached between the federal government and WEST “for the development of a massive coal-fired steam electric generating and transmission complex in Southwestern United States” that provided for “water contracts, utilization of Indian-owned coal, and transmission of rights-of-ways across Federal and Indian lands,” also spelling “out for the first time measures to abate air and water pollution resulting from the operation of proposed electric plants.”³⁶⁴ The plants - Mohave Generating Station and Navajo Generating Station – were scheduled for completion in 1971 and, in Udall’s words, “an additional step in the widespread, cooperative program of federal, public, and private power development” in the American West. “In addition to power benefits,” Udall continued, “substantial economic benefits to the Navajo and Hopi tribes will result from new markets created for their under-utilized coal resources.”³⁶⁵

Yet significant challenges still faced the men tasked with electrifying the Colorado Plateau, including the question of how to transport coal 275 miles across the desert from the Black Mesa mine to the Mohave Generating Station. Two proposals – transport by railway or by coal slurry pipeline – were on the table in 1966. The pipeline, which would require billions of gallons of Hopi and Navajo groundwater, was the more economic choice and would save Peabody Coal a significant amount of money over the life of the mine. The railway, on the other hand, was a more technologically responsible choice in a region where the scarcity of water conditioned everything from religion to agriculture. By January 1966 Peabody Coal completed a

³⁶⁴ Office of the Secretary of the Interior, “Agreement Reached on Developing Vast Coal-Fired ‘WEST’ Electric Complex,” April 12, 1966, Department of the Interior, 1963-1969: Box 34, Folder 2: Indian Affairs - News 7/65-6/66, Lyndon Baines Johnson Presidential Library.

³⁶⁵ Ibid.

study titled, “Feasibility of Obtaining a Ground Water Supply from Black Mesa, Az.” – six months before the company finalized their mining lease with the Hopi Tribal Council.³⁶⁶

While Peabody was investigating the feasibility of acquiring Hopi and Navajo water, the federal government began its own investigation into the feasibility of the pipeline itself. In the fall of 1966 Secretary Udall held a meeting with corporate representatives vying for future contracts to construct either the rail line or the pipeline that would transport Hopi and Navajo coal from Black Mesa to Mohave. Fred Marsh raised questions “as to the technical feasibility of the proposed coal slurry pipeline” and “as to the validity of the cost estimates made by the company which proposes to build the pipeline.” In response the Secretary Udall tasked the U.S. Bureau of Mines with investigating these issues. The agency found “no reason to believe that the pipeline is technically infeasible, or that the cost estimate is unreasonably low.” Udall reiterated that the Department of the Interior “cannot, and should not, attempt to dictate to the parties in interest whether the Black Mesa coal is moved by pipeline or rail, nor can we properly direct which company should provide either service.” The Department’s responsibility, rather, was “to see that the Navajos are fairly dealt with, and that the coal resource is economically developed.” Undersecretary Luce reminded Marsh that during the earlier conference the latter had stated that his “company was prepared to lower its present offer to Southern California Edison,” the principal utility involved in the construction of the Mohave plant, but that Marsh “doubted it could meet the pipeline offer.” Luce urged Marsh to “carefully consider” his position in the matter, reiterating that the Department did “not feel that we can properly ask the Edison

³⁶⁶ Colorado Plateau Environmental Advisory Council, “Completed Environmental Studies,” *Colorado Plateau Environmental Advisory Council Newsletter* 1, no. 3 (November 1970): 4.

Company, and other parties involved in the pipeline proposal, to delay the completion of a contract much longer.”³⁶⁷

By the beginning of the next month Secretary Udall was convinced that a coal slurry pipeline was indeed the most cost-effective technology to employ on Black Mesa. In a letter sent by airmail in early November 1966, Udall wrote to the president of the Bechtel, the company that would also go on to engineer and construct the Navajo Generating Station.³⁶⁸

I enjoyed our visit – and it appears that between you and your experts Interior is completely persuaded that the coal pipeline is the best answer to the Navajo coal transportation problem.³⁶⁹

There were no coal slurry pipelines operating in the United States when Bechtel, Peabody, the Department of the Interior, and Southern California Edison made the decision to build a coal slurry pipeline that would be owned by the Southern Pacific Railroad. The Black Mesa Pipeline would become only the second coal slurry pipeline ever constructed in the United States. The nation’s first coal slurry pipeline grew out of a Consolidation Coal Company research program in the late 1940s. By 1957 the company had completed construction of a pipeline that ran 108 miles from Cadiz, Ohio, to Cleveland.³⁷⁰ The Consolidation pipeline

³⁶⁷ Charles F. Luce to Mr. Marsh, “Pipeline Bids and Feasibility,” October 24, 1966, Stewart L. Udall Papers, University of Arizona Special Collections.

³⁶⁸ Colorado Plateau Environmental Advisory Council, “Visit to Kansas Power and Light Generating Station to Study SO₂ Control,” *Colorado Plateau Environmental Advisory Council Newsletter* 1, no. 4 (December 1970): 2.

³⁶⁹ Stewart L. Udall to S.D. Bechtel, Jr., November 7, 1966, Stewart L. Udall Papers, University of Arizona Special Collections.

³⁷⁰ Kenneth M Bertram and Gary M Kaszynski, “A Comparison of Coal-Water Slurry Pipeline Systems,” *EGY Energy* 11, no. 11 (1986): 1167.

operated for only six years, ceasing operations after Consolidation Coal railroad companies reduced the cost of transporting the coal to the Cleveland Electric Illuminating Company.³⁷¹

Operated by Black Mesa Pipeline, Inc., a subsidiary of the Southern Pacific Transportation Corporation, the country's second slurry pipeline began transporting Hopi coal and water across the desert in 1970.³⁷² According to the environmental statement filed by the Bureau of Reclamation two years after operations commenced, the coal was,

delivered through a slurry pipeline after being processed at the plant located on Black Mesa near the mining site. The mined coal is transported to the processing plant by truck and stockpiled. The coal is fed into the plant by a conveyor belt system where it is reduced to a near powder form, mixed with water 50 percent by weight, and pumped approximately 275 miles at a velocity of about 5 mph through a pipeline with four pumping stations to the Mohave Generating Station located in Nevada near Bullhead City, Arizona.³⁷³

The water supply for the slurry line originated from deep within the Navajo aquifer and reached the surface through five wells drilled by Peabody. In 1972 Peabody estimated, "that water use will not exceed 3,100 acre-feet per year and will average about 2,400 acre-feet per year over a 35-year period."³⁷⁴ The entire system cost a total of \$39 million to design, construct, and put into operation. Once the slurry made its way to the Mohave Generating Station, it was combusted "as in any conventional power plant."³⁷⁵

³⁷¹ B. E. A. Jacobs, *Design of Slurry Transport Systems* (Taylor & Francis, 1991), 286.

³⁷² *Ibid.*, 286.

³⁷³ Bureau of Reclamation, United States Department of the Interior, "Final Environmental Statement, Navajo Project," February 4, 1972, 87.

³⁷⁴ *Ibid.*

³⁷⁵ Bertram and Kaszynski, "A Comparison of Coal-Water Slurry Pipeline Systems," 1168.

While the Department of the Interior, WEST, Southern Pacific, Bechtel and Peabody, were busy executing plans to electrify the American West with indigenous coal, those residing on the Hopi mesas knew little about these plans or how they would affect the precious resources upon which their culture and livelihoods depended. When the Hopi Tribal Council finalized the coal lease with Peabody in June 1966, only a handful of Hopis outside the council were aware that Hopi water and coal had been promised to the coal company and WEST. Resistance to the leasing quickly mounted in the Hopi villages, particularly among the traditionalists who argued the Hopi Tribal Council was not representative of all Hopis and had no legal right to negotiate a lease with Peabody. This early outcry against the extraction of Hopi coal and water would set into motion a forty year struggle aimed at shutting down the Black Mesa Pipeline and preserving Hopi water for future generations.³⁷⁶

By the summer of 1970 many Hopis had learned details of the Tribal Council's agreement with Peabody, including the leasing of water from the Navajo aquifer to supply the company's wells at 2,700 gallons per minute to feed the Black Mesa Pipeline. They also learned that no environmental impact study had been conducted to assess the impacts of this pumping on water sources that were at once sacred and central to survival in an unforgiving desert environment. The lack of scientific inquiry into how this development would affect Hopi water and agriculture alarmed many, and in the summer of 1970 a delegation of twenty-five Hopis organized a visit the Black Mesa mine and slurry preparation plant.³⁷⁷ The delegation reported the experience of seeing sacred groundwater mixed with pulverized coal as unnerving, and this

³⁷⁶ Clemmer, "Black Mesa and the Hopi."

³⁷⁷ Ibid.

sparked more questions from them about the long-term ecological and agricultural impacts of Peabody's operations.³⁷⁸

As a result, Hopis from five villages quickly formed a coalition with non-Hopi organizations in California and New Mexico that included the Committee for Traditional Indian Land and Life, Central Clearing House, and Black Mesa Defense. Over the next several months, they worked together with community members organizing meetings, arranging press conferences, publishing articles, and soliciting donations. The funds raised were used to retain legal representation through the Native American Rights Fund, which later represented a group of Hopi traditionalists as they challenged the legitimacy of the Tribal Council's leasing of Black Mesa's water and coal.³⁷⁹

Recurring themes—the destruction of the Hopi food system, the appropriate use of coal transportation technology, and the centrality of groundwater to Hopi survival—peppered both legal challenges and public information campaigns that reached far beyond the Hopi mesas. The traditionalists involved claimed the Black Mesa Pipeline was a “corrupt use of technology.” They argued that the slurry system was neither culturally nor environmentally appropriate and would cause irreparable material damage to the water table.³⁸⁰ In a letter to Peabody and the Hopi Tribal Council, the traditionalists challenged coal slurry pipeline technology, arguing that Black Mesa coal should be transported instead by rail or truck. They argued that Peabody's pumping operations were an industrial waste of water that was critical to both the Hopi food system and the ecosystem at large. These Hopis also questioned Peabody's assertion that strip-

³⁷⁸ “Traditionalist Meeting with Outside Interests at Shungopavi,” August 30, 1970.

³⁷⁹ Clemmer, “Black Mesa and the Hopi,” 27.

³⁸⁰ Committee for Traditional Indian Land and Life, “Press Release: Committee for Traditional Indian Land and Life.”

mined lands could be reclaimed. Would reclamation processes not change the topography, flow of water, and types of plants and animals on Black Mesa? How would this impact the local food system? The Tribal Council, the traditionalists posited, had an obligation to protect the health of both people and the environment, not to operate solely for the benefit of outside corporations. “You can always make more money,” they argued, “but you can never make another world.”³⁸¹

Some Hopis saw the development of Black Mesa’s coal reserves as signaling the destruction of an ecological system in which the health of water, crops, and livestock was intimately linked to human health. They argued that the desert’s meager rainfall could never replenish underground aquifers, and predicted rapid groundwater depletion. Without water, stalks of blue corn would wither along with livestock forage, leaving their sheep with nothing to eat or drink. The springs and seeps upon which Hopi gardens and orchards depend would dry up, killing irrigated crops like beans, melons, and peaches. Impoundments and open pits would allow rainwater to collect and dissolve chemicals from the coal, while at the same time diminishing the flow of water to downstream farmers.³⁸² Some Hopis claimed that sulfur concentrates from coal processing were already seeping into drainage areas by 1970, damaging Hopi crops and livestock operations in Moenkopi village.³⁸³ The group took their concerns Bureau of Indian Affairs Superintendent Homer Gilliland, inquiring about what the Bureau and the Hopi Tribal Council

³⁸¹ Mina Lansa and Claude Kewaheouma, “Letter from Mina Lansa (Chief, Old Oraibi) and Claude Kewaheouma (Chief, Shungopavi) to Mr. Clarence Hamilton, Chairman; Mr. John S. Boyden, Tribal Lawyer; Members, Hopi Tribal Council,” August 6, 1970.

³⁸² Hopi Independent Nation, “Notice for 9/12-13/70 Shungopavy Meeting,” September 2, 1970.

³⁸³ Central Clearing House, “Black Mesa Problem,” August 28, 1970.

were doing to address these concerns. Gilliland admitted that there was no plan to investigate the existing or potential future impacts of Peabody's operations on Hopi agriculture.³⁸⁴

In less than a year of the delegation's visit to the slurry preparation plant, Hopi concerns over the Black Mesa mine had travelled far and wide, reaching national audiences in West Coast ecology magazines, independent film and video projects, and major newspapers including the *New York Times* and *Washington Post*. Walter Cronkite had even featured a clip of Mina Lansa and other Hopis. In the wake of this publicity and with legal representation from the Native American Rights Fund, traditionalist leaders from five Hopi villages filed suit against Peabody Coal Company the Secretary of the Interior Rogers Morton in May 1971. The plaintiffs charged that the Peabody lease was unlawful because the Hopi Tribal Council was not a legally constituted body, the Department of the Interior had approved the lease without informing Hopis of possible ecological and agricultural implications, and that the lease was in violation of Hopi culture, religion, and way of life.³⁸⁵ Two years later a Phoenix court ruled the Hopi Tribal Council was an indispensable party to any lawsuit concerning the mine since it had signed the lease. Therefore the traditionalists were not the proper entity to file suit. The Ninth Circuit Court of Appeals upheld the decision in 1975, and the Supreme Court refused to hear the case, effectively ending legal recourse for the time being.³⁸⁶

By the time the Supreme Court refused to hear the case, few avenues for stopping the slurry pipeline or the larger Navajo Project of which it was a part were available to those resisting the electrification of the Colorado Plateau. On February 4, 1972 the Bureau of

³⁸⁴ Committee for Traditional Indian Land and Life, "Press Release," 1970, MS 374, University of Arizona Special Collections, Tucson, Arizona.

³⁸⁵ Leroy F. Aarons, "Mesa Mines: Hopis Profit at a Price," *Washington Post*, June 7, 1971; Clemmer, "Black Mesa and the Hopi," 28.

³⁸⁶ Clemmer, "Black Mesa and the Hopi," 31.

Reclamation filed the Final Environmental Statement for the Navajo Project with the Council on Environmental Quality. Despite the fact that the “basic course of action initiating work on the power project was established prior to the effective date” of the National Environmental Policy Act of 1969, an environmental statement was “prepared pursuant to Section 11 of the Guidelines of the Council on Environmental Quality.” The document provided an overview of the Navajo Project, whose major features included the Navajo Generating Station that would allocate its majority share of electricity to the Central Arizona Project, the Black Mesa and Lake Powell Railroad that moved Black Mesa Coal to Navajo Generating Station, the Black Mesa Coal Mining Operation that included both the Black Mesa and Kayenta mines, and the Southern and Western Transmission Systems that would move electricity from the Navajo Generating Station to utilities in Arizona, Nevada, and California.³⁸⁷

A brief discussion of the slurry pipeline and Peabody’s pumping of Hopi and Navajo groundwater is included in Section V of the Environmental Statement, along with a statement addressing groundwater concerns brought forth by citizens when the Draft Environmental Statement was open to comment the previous year. According to Bureau of Reclamation,

Comments received suggested that the high quality water should not be used for slurry purposes but should be saved for the Indians. The underground water underlying Black Mesa extends very deep. As explained herein, the Indian wells are shallow, and protective measures have been included to preclude adverse effects. Water for slurry purposes is withdrawn from the deeper aquifers. Portions of the water withdrawn by pumping will be replaced through natural processes.³⁸⁸

³⁸⁷ Bureau of Reclamation, United States Department of the Interior, “Final Environmental Statement, Navajo Project.”

³⁸⁸ *Ibid.*, 87,

In the report's discussion of "irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented," Bureau officials stated that,

An average of 2,400 acre-feet of ground water in storage will be removed each year over the 35-year life of the Mohave Generating Station for a total over that period of some 100,000 acre-feet. To a substantial degree, portions of this water will be replaced by natural rainfall, thus recharging the underground sources from which the slurry water is extracted.³⁸⁹

And while the Bureau presented the theory that rainfall would recharge the aquifer, it also included concerns about the effects the pumping would have on local people, but only in Navajo communities north of the mining operations. Yet, even if drawdown did occur, Peabody's obligation to provide these communities with water seemed an acceptable concession to the Department of the Interior as they expressed their concerns in the Final Environmental Statement:

Pumping from the deep wells underlying Black Mesa to slurry coal to the Mohave plant may affect the domestic wells in Kayenta and other Indian communities to the north, which draw from the same Navajo-Kayenta formation. Hydrologists do not agree whether these domestic wells are in the same pressure zones as the Peabody wells, but a monitoring program has been devised to ascertain those facts. In the event the supply of the water to the Indian wells is affected, Peabody is under a contractual obligation to provide the Indians with water in quality and quantity equal to that formerly available to them.³⁹⁰

³⁸⁹ Ibid., 94.

³⁹⁰ Ibid., 94.

Potential adverse effects of Peabody's pumping operations on Hopi water resources were not mentioned in the statement. In fact, additional hydrological investigations were not mentioned at all in "Further Studies Needed" section of the document.³⁹¹

Yet Hopi and Navajo concerns about the withdrawal of billions of gallons of water did result in the Black Mesa Water Monitoring Program, which is still in operation today. In 1971 a plan to monitor the effects of Peabody's mining activities on Black Mesa water supplies was put together with the cooperation of Peabody, the Bureau of Indian Affairs, the Hopi and Navajo Tribal Councils, and the U.S. Geological Survey. Under the plan a series of wells were to be drilled between the mining operations and communities to the north, east, and west of the mines to measure "the effect of Peabody's deep well pumping on those communities." Stream gauging stations would be placed in washes downstream from mining operations to "determine the variations in water quality," and sedimentation samples would be taken from the washes "immediately following heavy rains to determine what sediments, if any, are carried down the washes by reason of the mining activities." Finally, all the data would be "collected systematically, including rainfall records, and made available to all interested parties." The data would remain on file in the library of the Colorado Plateau Environmental Advisory Council at the Museum of Northern Arizona in Flagstaff where it could be "inspected and copied by the public."³⁹² The Arizona Department of Water Resources would also join the monitoring efforts.

The first report of the Black Mesa Water Monitoring Program was not published until nearly seven years after the program's inception, and it was not until the early 1980s that USGS scientists began issuing annual reports. Monitoring activities during this decade included the

³⁹¹ Ibid., 94.

³⁹² Ibid., 88.

periodic or continuous measurement of “(1) ground-water levels in the confined and unconfined areas of the N aquifer; (2) major withdrawals from the N aquifer by industrial and nonindustrial pumping from the confined and unconfined areas; (3) ground-water quality of the N aquifer in the coal-lease area and other areas of the mesa; (4) discharge and chemical quality of selected springs that discharge from the various formations, including the N aquifer; and (5) surface-water discharge, which reflects the conditions of the N aquifer.”³⁹³ Groundwater withdrawals from 1972-1986 averaged 5,480 acre-feet annually, with 3,820 acre-feet of these withdrawals used by Peabody’s mining operations.³⁹⁴ The mine’s withdrawals during this time were well over the annual 2,400 acre-feet Peabody claimed it would use back in 1971.

By 1983 USGS had developed its first two-dimensional groundwater flow model to simulate the effects of pumping on the Navajo aquifer over time. In 1986 Peabody applied to the U.S. Office of Surface Mining Reclamation and Enforcement (OSMRE) for a Life-of-Mine permit. OSMRE, however, would not grant the permit until the agency assessed the cumulative hydrologic impact of all anticipated mining activities. In 1988 USGS updated its groundwater model and in cooperation with OSMRE simulated the effects of different withdrawal scenarios on the N aquifer as part of the cumulative hydrologic impact assessment (CHIA).³⁹⁵ The 1989 CHIA included criteria for determining material damage that may have occurred to the N aquifer

³⁹³ George W. Hill, “Progress Report on Black Mesa Monitoring Program-1984” (Tucson, Arizona: U.S. Geological Survey, Prepared in cooperation with the Arizona Department of Water Resources and the U.S. Bureau of Indian Affairs, August 1985), 3.

³⁹⁴ James G. Brown and James H. Eychaner, “Simulation of Five Ground-Water Withdrawal Projections for the Black Mesa Area, Navajo and Hopi Indian Reservations, Arizona” (Tucson, Arizona: U.S. Geological Survey, Prepared in cooperation with the U.S. Office of Surface Mining Reclamation and Enforcement, February 1988), 1.

³⁹⁵ *Ibid.*, 3.

as a result of Peabody's pumping operation, but ultimately determined that the proposed mining would cause no material damage.

While federal agencies were busy calculating potential impacts of Peabody's pumping on the N aquifer, men and women living in the Hopi villages on the southern end of Black Mesa began noticing changes in the groundwater sources that their families had relied upon for generations. In December of 1988 Hopi Tribal Vice Chairman Vernon Masayesva traveled to Denver to testify before the Office of Surface Mining Reclamation and Enforcement. Masayesva told the OSMRE panel,

The primary interest and concern identified by the Hopi public is the surface and groundwater use by the mining and slurry operation. Declines in community wells, drying of sacred springs and diminution of perennial stream flows are causing concern. The Hopi public has stated that PCC's mining operation may be contributing to the problem.³⁹⁶

Masayesva continued with a critique of OSMRE's finding that Peabody would cause no material damage to the N aquifer, and informed the agency that the Hopi Tribe disagreed with their finding and had adopted a tribal resolution of which they submitted a copy to OSMRE along with a statement of the Hopi Division of Mining and Reclamation Enforcement's technical issues with OSMRE's CHIA.³⁹⁷

In addition to concerns over Peabody's extraction of sacred groundwater from the N aquifer, the Tribe was also raising questions as to the effects of Peabody's surface water impoundments. In 1982 Peabody submitted a permit application to OSMRE to construct surface

³⁹⁶ "Vice Chairman Masayesva Testify before OSMRE in Denver," *Tutuveni*, December 16, 1988, 2.

³⁹⁷ Ibid.

water impoundments. The agency issued the permit without seeking the Tribe's approval and did not provide the Hopi Tribe with a lease for the use of its surface water or question whether the Tribe should receive compensation for the water impounded by dams and ponds. Over the next several years, in 1984, 1985, and 1986, the Hopi Tribe appealed OSMRE's decision to issue permits to Peabody. In the words of Tribal Chairman Sidney, "concerns over surface water impacts were at the core of each appeal." In June of 1989, Sydney testified before a Senate Special Committee regarding Hopi concerns over these and other issues surrounding the use of Hopi waters by Peabody Coal. Sydney asked the Senators,

The Hopi Tribe, its consultant, and recently the BIA and EPA have raised concerns about OSM's analysis of water issues. The Hopi Tribe wonders who will resolve the conflicting views of OSM, BIA and EPA. Does any entity recognize a federal responsibility to protect Hopi water rights?³⁹⁸

Later on that summer, OSMRE held hearings regarding the Draft Environmental Impact Statement (DEIS) that was prepared along with the CHIA in response to Peabody's 1986 application for a Life-of-Mine permit. Hopis from various villages attended to comment on the DEIS, including Moenkopi rancher Dennis Tewa were in attendance. Tewa questioned the ability of scientists to forecast the aquifer's future and instead argued that Hopis themselves were the experts. Tewa, who had worked on wells throughout the region during the past several years, had witnessed water levels drop hundreds of feet, an observation that was in stark contrast to the "upbeat ring" of the DEIS. Hydrologists, argued Tewa, "only work on theories. They don't have X-ray to look into the ground. We Hopi people are the experts on that."³⁹⁹

³⁹⁸ "Sidney Addresses Water and Coal Issues," *Tutuveni*, June 16, 1989.

³⁹⁹ Mark Shaffer, "Mining Angers Hopis, Navajos," *The Arizona Republic*, August 14, 1989, sec. B, B2.

The following month Hopi Tribal Chairman Ivan Sidney spoke before the Department of the Interior, reiterating Hopi concerns that he originally voiced during scoping sessions for the EIS: (1) The Black Mesa hydrologic basin should be evaluated in its entirety and must include mining impacts on both ground and surface water. (2) The 58 surface water impoundments proposed in the DEIS affect Hopi water rights and farmers in Moenkopi; neither the DEIS nor the CHIA address the effects of these impoundments on downstream users. (3) Hopi springs and wells are drying up or have significantly reduced output. This reduced water availability threatens Hopi culture and farming. (4) The model should account for future domestic water needs. (5) Mining operations have destroyed the Wepo and shallow alluvial aquifers and the Surface Mining Control and Reclamation Act of 1977 requires Peabody replace these water sources. (6) The DEIS does not adequately consider reasonable coal transportation alternatives to the slurry line. In closing, Sidney, on behalf of the Hopi Tribe, asked for an extension of the comment period on the DEIS and CHIA, stating, “The Hopi people do not believe that the EIS and CHIA support the conclusions of ‘no material damage to the hydrologic balance.’”⁴⁰⁰

OSMRE submitted the Final Environmental Impact Statement in May 1990, the same month that month Hopi Tribal Chairman Vernon and Tribal Councilman Daniel Honahni traveled to Washington, D.C. where they met with the Assistant Secretary of the Interior for Indian Affairs, the Assistant Secretary of the Interior for Land and Minerals Management, and the Director of the Office of Surface Mining Reclamation and Enforcement to discuss the pending Black Mesa-Kayenta Mine permit application on May 24, 1990. At the meeting Masayesva stressed that, “critical environmental issues are not being addressed fairly and

⁴⁰⁰ “Statement of Chairman Ivan Sidney - Black Mesa/Kayenta Coal Mines,” *Tutuveni*, September 14, 1989, 2.

responsibly.” These issues included Peabody’s continued pumping of groundwater to feed the slurry pipeline system as well as the company’s proposed retention and construction of 223 surface water impoundments controlling flow and drainage throughout much of the Dinnebito and Upper Moenkopi basins. Chairman Masayesva also urged the Department of the Interior to explore alternative modes of transporting the coal.⁴⁰¹

In July 1990 Secretary of the Interior Manuel Lujan issued a Life of Mine permit for the Kayenta Mine, but postponed a decision on the Black Mesa Mine invoking his trust responsibility to the tribes.⁴⁰² The Black Mesa permit would be delayed until additional studies regarding Peabody’s impact on tribal waters were completed. The Secretary also called for an alternative coal transportation study. Both Hopis and Navajos had repeatedly pointed out the failure of the EIS to consider alternatives to the coal slurry pipeline. They claimed such negligence was a violation of the National Environmental Policy Act, which requires the consideration of alternatives to the proposed action.⁴⁰³ Masayesva spoke on behalf of the Hopi Tribe, celebrating Lujan’s decision:

The Hopi Tribe believes Peabody’s pumping is causing the lowering of our wells and diminishing the flow of springs, and that damage will become more severe as unrestricted pumping continues. Secretary Lujan understood our concerns and took a necessary [step] to guarantee Hopi survival. His wise and courageous decision to further study groundwater and alternative transport issues demonstrate that he is taking federal trust responsibility toward Indians seriously.⁴⁰⁴

⁴⁰¹ “Critical Issues Not Fairly Addressed in EIS,” *Tutuveni*, June 1990.

⁴⁰² George Hardeen, “Secretary Lujan Issues ‘Life of Mine’ Permit,” *Navajo Times*, July 19, 1990.

⁴⁰³ *Ibid.*

⁴⁰⁴ “Water Is Essential to Future Hopi Survival,” *Tutuveni*, July 25, 1990.

The Department of the Interior appropriated \$800,000 to the alternative transport study.⁴⁰⁵ At Secretary Lujan's request, the Hopi Tribe put together a legal and technical team to prepare a proposal to study alternative coal transportation technologies over the next several months. In March of 1991 the group traveled to Washington, D.C. to present the Hopi Tribe's proposal to Lujan. The proposal was built around the protection of Hopi groundwater for future generations, a tenet Masayesva reiterated as "imbedded in the Hopi teachings of sustainability."⁴⁰⁶

Over the next decade Peabody, the Department of the Interior, and the Hopi and Navajo Tribes struggled to reach a consensus on an alternative means of transporting coal from the Black Mesa mine, despite the millions of dollars spent to reach a solution. Since transporting the coal by rail was deemed to be cost prohibitive, alternative water sources became the focus of the efforts instead of alternative technologies and transportations. The most popular proposal was to build a pipeline from Lake Powell to Black Mesa so that Colorado River water could be used to slurry the coal to the Mohave Generating Station, as well as provide additional domestic water supplied to the Hopi and Navajo people. In the end, however, an agreement was not reached and Lake Powell's waters never made the journey to Peabody's slurry plant. The struggle to end Peabody's groundwater pumping continued into the 21st century, stopping only when the Black Mesa Mine and pipeline were shut down on December 16, 2005. A little over two weeks later, on December 31, 2005, the Mohave Generating Station ended operations after Southern California

⁴⁰⁵ George Hardeen, "Navajo, Hopi Tribes Concerned about \$800,000 Study Funds," *Navajo Times*, September 26, 1991.

⁴⁰⁶ "Hopi Tribe Presents Proposal on Alternative Transport of Coal," *Tutuveni*, April 4, 1991.

Edison failed to retrofit the plant with pollution controls as mandated in the 1999 consent decree.⁴⁰⁷

While the closure of the Mojave Generating Station was seen as a victory by Hopis opposed to Peabody's use of groundwater for the Black Mesa Pipeline, new challenges to water quality had emerged on the reservation during the late 20th century. In 1995 radioactive contamination in the groundwater near the Hopi villages of Upper and Lower Moenkopi was discovered after the Bureau of Indian Affairs began an environmental monitoring program near the Tuba City Open Dump. Beginning in the 1940s, the site served as an open dump and was not regulated. This lack of regulation translated into the absence of documentation of what exactly was dumped at the site, but the U.S. Environmental Protection Agency believes that "uranium-contaminated waste, equipment, or tailings may have been disposed of at the dump." Shallow water extremely close to the dump is also "contaminated with elevated levels of arsenic, chloride, lead, total dissolved solids (TDS), chromium, nitrate, selenium, strontium, sulfate, and vanadium."⁴⁰⁸ The plume of radioactive water is making its way toward Hopi villages, threatening to contaminate water supplies for both Upper and Lower Moenkopi.⁴⁰⁹

The Tuba City Open Dump is now a Superfund site, and tribal, state, and federal agencies are working collectively toward effective environmental remediation. While the source of pollutants threatening groundwater in the Hopi Indian Reservation's westernmost villages is discernable, causes of groundwater pollution on other mesas is not as clear. In Keams Canyon,

⁴⁰⁷ Higgins, *The Black Mesa Case Study*, 195.

⁴⁰⁸ Region 9 US EPA, "Site Overviews, Tuba City Open Dump, US EPA, Pacific Southwest, Superfund," Overviews & Factsheets, accessed February 17, 2015, <http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/ViewByEPAID/NND982400145#descr>.

⁴⁰⁹ "Radioactive Water near Hopi Springs," *Arizona Daily Sun*, accessed February 17, 2015, http://azdailysun.com/news/radioactive-water-near-hopi-springs/article_bb55fbf4-325a-5b57-a4af-3f122aef3ef9.html.

arsenic levels in the water system that serves 2,000 Hopis and is operated by the Bureau of Indian Affairs were in violation of the Safe Drinking Water Act in 2011. While the system is now compliant, the source of pollution is still questioned.⁴¹⁰

Since 1930 Hopi water resources have undergone significant changes, altering physical and social environments in the process. While toxic pollution threatens human health, dwindling groundwater levels are cause for alarm to the ranchers, farmers, and gardeners who depend on them. Discerning the causes of these changes is often difficult and fraught with sociopolitical tensions. Yet the reality of significant shifts in Hopi water over this time period is apparent in the memories and daily observations of farmers, gardeners, and ranchers who have spent their lives monitoring these resources. Over time, men, women, and children began to notice changes in the water with which they irrigated their crops, in the windmills that pumped water for their sheep and cattle, and in the springs that had once been the lifeblood of their communities. These shifts in water resources are becoming increasingly stressful for Hopi farmers and ranchers as the planet grows hotter and drier. Hopi ecological knowledge is a critical resource for deepening our understanding of environmental change over time, the effects of dwindling water resources on agriculturalists, and the ways in which climate change is playing out in the cornfields of North America's oldest farmers.

⁴¹⁰ “09/24/2013: EPA Fines BIA \$136,000 for Keams Canyon Drinking Water Violations on the Hopi Reservation,” accessed February 17, 2015, <http://yosemite.epa.gov/opa/admpress.nsf/2dd7f669225439b78525735900400c31/00a29c1126225bd185257bf0005342af!opendocument>.

CHAPTER FOUR LOCAL KNOWLEDGE AND ECOLOGICAL CHANGE

On a searing summer afternoon I made my way down a steep sandstone path toward the edge of a canyon on the outskirts of the Third Mesa village of Bacavi, a canyon whose walls were home to high and narrow garden terraces once overflowing with chilies, onions, purple string beans, sweet corn, saffron, and amaranth.⁴¹¹ It was a Friday in late August and on the neighboring mesa the village of Mishongnovi was preparing for the Snake Dance. As the Hopi woman leading me down to the ancestral gardens explained she was in prayer with those preparing for the ceremony, she stopped to lament on the state of the empty terraces explaining that one section was sorely in need of repair. This, she thought, could be done as many of the terraces were restored in the 1990s after decades of minimal use that invited a creeping sort of deterioration. Yes, the terraces could be restored. But the water, she explained, was another issue. About five years earlier two of the five springs that once provided water to the gardens had dried up and she had not planted her garden since then.

Over the next five years the remaining springs in the Bacavi terrace gardens gradually dried up. The decline that had begun with the two springs located in the lowest terraces slowly crept up the canyon slope until only the topmost spring was discharging any discernable amount. By the summer of 2013, when I returned to Third Mesa to conduct interviews for this project, a farmer explained to me that, “pretty much nobody gardens down there anymore because of the springs being dried up.” I asked him what was responsible for the water’s departure. The reason, he explained, was long-term drought. Not enough snow was falling on the mesas, and while the

⁴¹¹ Volney H. Jones, “Notes on Hopi Spring Gardens,” October 10, 1935, Alfred F. Whiting Notes and Papers, Northern Arizona University Cline Library Special Collections and Archives.

monsoon storms did arrive each summer it just wasn't enough precipitation when he examined each year as a whole.⁴¹² Like his fellow gardener, this farmer had been born on the Hopi Indian Reservation in the 1950s. Both experienced a childhood filled with seasons of gardening as they helped their mothers and grandmothers in the Bacavi terraces, and over time each witnessed a steady decline in the number of folks who continued to grow the purple beans, sweet corn, and red amaranth that had colored their childhoods and filled the gardens. By the 1990s both were involved in restoring the gardens of Bacavi Canyon to their former splendor, working with fellow villagers and professors from Northern Arizona University. And within twenty years of the restoration both observed the springs upon which their gardens depend dwindle to a mere trickle.

The springs of Bacavi Canyon, the garden terraces that once flourished, and the local knowledge of those who observed changes in these water resources over time serve as an entry point into an examination of changing water resources on the Hopi Indian Reservation, local knowledge as a tool for assessing ecological change over time, and understanding how climate change is affecting agriculturalists on the ground.

As farmers, gardeners, and ranchers, the Hopi men and women I interviewed for this project shared with me a diverse set of ecological observations rooted in the dry farmed fields, terraced gardens, and expansive rangelands from which they tend their crops and livestock. Dependent on soil, sun, rain, and groundwater, these producers are intimately aware of even the tiniest change in weather patterns, spring discharge, or plant populations. Their shared dependency on the local environment to continue traditional agricultural practices much in the same ways their ancestors did a thousand years ago positions these agriculturalists as key

⁴¹² Hopi man, interview by author, Kykotsmovi, AZ, June 5, 2013.

observers in a rapidly changing world. And while their perceptions of what is causing these changes are sometimes at odds with those of their peers, federal agencies, or multinational corporations, their collective and individual observations of dwindling water resources, unusual animal behavior, or a changing climate are key to assessing the scope, rate, and implications of environmental change.

Scholars have explored the intimate relationships among indigenous cultures, local environments, and ecological knowledge in contexts ranging from earthquakes to melting sea ice.⁴¹³ Culturally and ecologically situated, local ecological knowledge is a valuable resource. As studies conducted with indigenous populations across the globe demonstrate, agriculturalists like the Hopi possess intimate knowledge of the environments in which they live and work.⁴¹⁴ The incorporation of local knowledge into scientific studies is more relevant to local people, facilitates local participation in natural resource debates and conservation, and positively affects

⁴¹³ Coll Thrush and Ruth S. Ludwin, "Finding Fault: Indigenous Seismology, Colonial Science, and the Rediscovery of Earthquakes and Tsunamis in Cascadia," *American Indian Culture and Research Journal* 31, no. 4 (January 2007): 1–24; Angela Cavender Wilson, "Introduction: Indigenous Knowledge Recovery Is Indigenous Empowerment," *The American Indian Quarterly* 28, no. 3 (2004): 359–72; Jay B. Norton, Roman R. Pawluk, and Jonathan A. Sandor, "Observation and Experience Linking Science and Indigenous Knowledge at Zuni, New Mexico," *Journal of Arid Environments* 39, no. 2 (1998): 331–40; Deborah McGregor, "Coming Full Circle: Indigenous Knowledge, Environment, and Our Future," *American Indian Quarterly* 28, no. 3/4 (July 2004): 385–410; M.T Bravo, "Voices from the Sea Ice: The Reception of Climate Impact Narratives," *Journal of Historical Geography* 35, no. 2 (2009): 256–78.

⁴¹⁴ Jay B. Norton, Roman R. Pawluk, and Jonathan A. Sandor, "Observation and Experience Linking Science and Indigenous Knowledge at Zuni, New Mexico," *Journal of Arid Environments* 39 (1998): 331–40; Paul Sillitoe and Julian Barr, "A Decision Model for the Incorporation of Indigenous Knowledge into Development Projects," in *Investigating Local Knowledge: New Directions, New Approaches*, ed. Alan Bicker, Paul Sillitoe, and Johan Pottier (Burlington: Ashgate, 2004), 59–88.

sustainable adaptation to shifting environmental circumstances.⁴¹⁵ It is valuable to the formation of policy, although it stands on uneven footing compared with conventional scientific evidence and is often ignored by policymakers.⁴¹⁶ Viewed historically, local knowledge provides a more holistic understanding of ecological processes, such as the shifting nature of climate and water resources on the Hopi Indian Reservation from the late 20th century through the present. The analysis of such knowledge, as this chapter suggests, is seldom clear-cut. Oftentimes its incorporation into larger historical narratives complicates rather than refines questions of causality. And while it is outside the scope of this project to assess the causes of changes in climate and water resources that Hopi agriculturalists have been observing over the past several decades, the changes themselves have critical implications for the future of farming, ranching, and gardening on the Hopi Indian Reservation and as such deserve the attention of scholars and natural resource managers alike.

Over the past forty years, Hopi agriculturalists have been observing shifts in groundwater resources, weather patterns, and surface water. Each of these water resources plays an important role in sustaining farming, ranching, and gardening on the Hopi mesas and agriculturalists have noted declines in these resources over the past several decades. A decline in the availability of water for agricultural purposes – be it rain for dry farmed fields of corn, spring water for terraced gardens, or windmill-powered wells for Hopi livestock – often has significant consequences for

⁴¹⁵ Alan Bicker, Paul Sillitoe, and Johan Pottier, eds., *Development and Local Knowledge: New Approaches to Issues in Natural Resources Management, Conservation and Agriculture* (London; New York: Routledge, 2004).

⁴¹⁶ Frank Fischer, *Citizens, Experts, and the Environment: The Politics of Local Knowledge* (Durham and London: Duke University Press, 2000); Suryanarayanan S. and Kleinman D.L., “Be(e)coming Experts: The Controversy over Insecticides in the Honey Bee Colony Collapse Disorder,” *Social Studies of Science* 43, no. 2 (2013): 215–40; Stephen Bocking, *Nature’s Experts: Science, Politics, and the Environment* (New Brunswick, NJ: Rutgers University Press, 2004).

the successful continuation of agriculture on the reservation. Choices to continue these practices are individual and are conditioned by ecological circumstance. Some farmers and ranchers are adapting practices, others are continuing without adaptation, and some are choosing not to plant or ranch when the water supply or weather conditions are not sufficient to facilitate some degree of success.

This chapter is organized around agricultural spaces on the Hopi Indian Reservation – terrace gardens, irrigated fields, rangeland, and dry farmed fields. It begins with historical observations of each to establish its importance as a space of food production and a place where agriculturalists are keen observers of their environment. In each of these spaces the observations of gardeners, farmers, and ranchers are examined within the context of changing water and weather conditions since the 1970s, touching upon the variability in and difficulty of assigning causality to the changes. And finally, the implications of these changes for the practices of gardening, farming, and ranching are examined through the eyes and voices of Hopi men and women.

The spaces where Hopi men and women have produced food for over a thousand years are diverse, with each playing a specific role in the overall functioning of the food system. Through much of the 20th century irrigated terrace gardens served as critical locales of food production. The agrobiodiversity developed by Hopi gardeners in terraces across the mesas as well as the intricacy of the indigenous irrigation systems that supported these crops intrigued ethnobotanists who traveled to Hopi in the 1930s. Volney Jones was one such visitor.

In October of 1935 Volney Jones traveled from Ann Arbor, Michigan, to the Hopi mesas where he made extensive observations of what he called “Hopi spring gardens.”⁴¹⁷ Employed by the University of Michigan’s Museum of Anthropology, where he served as Curator of Ethnology Melvin Gilmore’s assistant in the museum’s newly established Ethnobotanical Laboratory, Jones came to Arizona at the request of the Museum of Northern Arizona’s Alfred Whiting.⁴¹⁸ As an up and coming leader in the burgeoning field of ethnobotany, Jones would assist in an ethnobotanical survey of the Hopi mesas. The botanical materials Jones and Whiting collected would be used to establish collections at both the Museum of Northern Arizona and in the University of Michigan’s Ethnobotanical Laboratory.⁴¹⁹

Jones’ notes on the terraced gardens at Hopi are perhaps the most detailed historical documents penned by a non-Hopi concerning the gardens’ construction, irrigation, and state of biodiversity during this period, providing a representation of the centrality of these spaces of production to Hopi culture and the food system as a whole. When Jones arrived on the Hopi mesas in early October 1935, the terrace gardens on each of the three mesas embodied what Hopi Cultural Preservation Office Director Leigh Kuwanwisiwma would describe nearly sixty years later. The gardens translated into “sustenance of life itself, like the recognition of food for survival, prayer for rain, prayer for springs – which, to the Hopi, is very much alive.”⁴²⁰ Just as rain, spring water, and food were living embodiments of survival on the Hopi mesas, so too were

⁴¹⁷ Jones, “Notes on Hopi Spring Gardens.”

⁴¹⁸ “Volney H. Jones,” *History | Museum of Anthropological Archaeology | University of Michigan*, accessed March 10, 2015, http://www.lsa.umich.edu/ummaa/about/history/volneyhjones_ci.

⁴¹⁹ Alfred F Whiting, “Hopi Crop Survey: Preliminary Report,” no date., Alfred F. Whiting Notes and Papers, Northern Arizona University Cline Library Special Collections and Archives.

⁴²⁰ “Restoration of Hopi Agriculture Progresses,” *Tutuveni*, July 29, 1993.

the terraced spaces where women, children, and the elderly cultivated crops that often served as a sort of insurance policy when dry farmed fields failed in the face of drought or destruction.

Led by Edmund Nequatewa, a Hopi from the village of Mishongnovi, Jones made his way across the Hopi mesas from west to east surveying the gardens.⁴²¹ On October 10, 1935 the team traveled from their base on Second Mesa to the Third Mesa village of Hotevilla, which was home to one of the largest gardens on the Hopi Indian Reservation. Here he observed a large spring flowing from a ledge about fifty feet below the rim of the mesa. The spring was dammed and its waters flowed through a metal pipe to the upper garden terraces from whence they traveled through a series of ditches and diverted to different plots. The garden itself was terraced in ledges approximately eight to ten feet wide and between three and five feet high. Hopi chilies planted in short rows emerged from the center of most plots along with hills of yellow saffron and red amaranth. Many of the plots displayed hills of sweet corn in their corners or planted in rows edged in by purple, red, and white string beans. Onions were present in most plots and fruit trees including peaches and apples were scattered throughout the terraces.⁴²²

When the group arrived in Bacavi canyon the following day, Jones noted the gardens and their crops were much like those at Hotevilla with the exception of the terraces being “higher and narrower to accommodate the greater degree of the canyon slope.” Overflow from a walled in spring with a pump and several additional springs scattered throughout the plots irrigated the garden. The water, Jones noted, was “carried along in various ingenious ways – trenches,

⁴²¹ For more on Nequatewa’s life, see Edmund Nequatewa, Alfred F Whiting, and P. David Seaman, *Born a Chief: The Nineteenth Century Hopi Boyhood of Edmund Nequatewa, as Told to Alfred F. Whiting* (Tucson: University of Arizona Press, 1993).

⁴²² Jones, “Notes on Hopi Spring Gardens.”

wooden flumes, metal pipes” – to reach chilies, onions, beans, saffron, amaranth, sweet corn and peach, apple, and apricot trees.⁴²³

Over the next several days Jones and Nequatewa visited gardens below the Second Mesa villages of Shipaulovi and Mishongnovi, fed by Toreva and Lemeva springs, before arriving at the First Mesa gardens of Wepo Springs. Here, on the west side of First Mesa about five or six miles up Wepo Wash Nequatewa led Jones to three large springs. Discharging about halfway up the mesa’s steep slope, the springs’ waters flowed down into high, narrow terraces built of stone. The water, controlled by a series of trenches and dams, gave life to a diverse array of crops. Like the gardens on Second and Third Mesa, chili and onion were numerous. Rows of sweet corn, tomatoes, radishes, beets, lettuce, and coriander lined individual plots that were occasionally graced by the presence of watermelon, pumpkin, and amaranth. Pole and bush beans were in abundance and entire plots were dedicated to carrots alone. An impressive grove of apple trees was thriving below one of the springs as well as a few peach trees. Great quantities of mint grew along the terrace walls and the springs, creating a border that was at once fragrant and useful.⁴²⁴

The final stop on Jones’ tour of Hopi gardens was the Awatovi gardens in the Talahogan springs region near the reservation’s southeastern border. Here the ethnobotanist recorded observations of a “moderately large” and “good flowing water supply.” The gardens here differed markedly from other Hopi gardens only in their greater proportion of orchards. Where on the other mesas fruit trees were “chiefly scattered and incidental,” at the Awatovi gardens whole plots were dedicated to apricot, peach, and apple trees as well as grape vines.⁴²⁵

⁴²³ Ibid.

⁴²⁴ Ibid.

⁴²⁵ Ibid.

The gardens to which Edmund Nequatewa guided Volney Jones in the fall of 1935 remained central components of the Hopi food system throughout much of the twentieth century, serving as spaces where both cultural diversity and biodiversity thrived as knowledge about plants, water, and technology passed from one generation to the next. Hopis born in the 1940s and 1950s recall distinct memories of these spaces where, as children, they helped parents and grandparents grow many of the crops Jones observed decades earlier. In the villages of Mishongnovi, Bacavi, and Hotevilla and at Wepo Springs the ecological and cultural systems upon which successful terrace gardening depended exhibited signs of health and resilience into the 1970s.

During the 1960s at least thirty plots of irrigated crops flourished at Wepo Springs where a constant flow of water from the cliffside spring made its way through sandstone-lined ditches, giving life to the terraces as it had for generations. Persistent in the minds of those who spent childhood summers at Wepo are sensory memories of a place that was colored in shades of green - alive with water, plants, and animals. “I heard a lot of birds in the orchard areas,” remembered a Hopi farmer who spoke with me in the fall of 2013, “and the trickling of water as we would release it down the slope to our gardens. I felt the mud and the soil. You could smell it all day – a combination of soil and plants, vegetation.”⁴²⁶ “The ground there,” one Hopi woman told me, “was always moist.” Walking on the earth was like stepping on a sponge and it “always smelled like it was raining over there.”⁴²⁷ Water often ran through Wepo Wash and a single grove of aspen trees found itself playing host to hordes of fireflies come dusk. Tadpoles, frogs, and

⁴²⁶ Hopi man, interview by author, Kykotsmovi, Arizona, November 7, 2013.

⁴²⁷ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

salamanders worked their way through water and soil, once in a while appearing as the star of a young girl's classroom show and tell.

Families continued to plant at Wepo Springs in the 1970s and 1980s, despite the socioeconomic changes that had swept across the Hopi mesas in the preceding decades causing an overall decline in traditional agricultural production. A man who helped his grandfather tend the family terrace during this time recalls a vibrantly green space filled with animals and insects that thrived on Wepo's waters. "When you walked up there," he remembers, "you could feel the moisture, the humidity just from the water." There was so much water, he says, that the spring would often overflow from the cistern tank.⁴²⁸ By the 1990s, however, the hydrologic environment at Wepo Springs began to change as gardeners noticed that the spring was slowly withdrawing. There was no longer a heavy charge in the spring. This decreased access to water began creating problems amongst those still working Wepo's terraces, causing some to abandon the site altogether when conflict over the limited water resource arose.⁴²⁹

Hopis made similar observations of declining spring discharge in terrace gardens across the mesas during the 1990s and 2000s. At the Hotevilla terrace gardens on Third Mesa Hopis reported a decline in the amount of water produced by the spring in 1999, noting that, "sometimes the garden has a problem keeping enough water in it to nourish the crops."⁴³⁰ Producing only three gallons per minute, this was a significant decline from the ten gallons per minute reported by the Bureau of Indian Affairs in 1944.⁴³¹ Villagers made similar observations in the gardens below the village of Mishongnovi and by the mid-1990s few if any families were

⁴²⁸ Hopi man, interview by author, Kykotsmovi, Arizona, April 12, 2013.

⁴²⁹ Hopi man, interview by author, Kykotsmovi, Arizona, April 12, 2013.

⁴³⁰ Debra Moon, "Timeworn Women's 'Husbandry' Still a Thriving Practice," *Tutuveni*, August 31, 1999.

⁴³¹ *Ibid.*; "Long Range Program for the Hopi Tribe, Arizona, March 1944."

continuing to cultivate the plots there.⁴³² The decline in gardening may or may not have been facilitated by dwindling water supplies, however, as the practice of terrace gardening as a whole had declined across the Hopi mesas by this time due to the broader socioeconomic and technological changes including the installation of modern plumbing which allowed for the planting of a garden closer to one's place of residence.

In some communities, like the village of Bacavi, terrace gardens were uncultivated as early as the 1970s. In an effort to restore the terraces and rejuvenate the practice of gardening, Leigh Kuwanwisiwma, director of the Hopi Cultural Preservation Office, began working with Miguel Vasquez and George Van Otten, both professors at Northern Arizona University in the early 1990s. These efforts aimed to engage as many villagers as possible in what was once an important part of Hopi life. "There was a sense and purpose to terrace gardening when we were growing up," explained one Bacavi woman involved in the restoration project. "We were given this responsibility and expected to maintain it. But we lost a whole generation and we are trying to bring it all back."⁴³³

For eight summers Vasquez, students from Northern Arizona University, and villagers worked to restore the terraces and by 1997 nearly one-third of the village was gardening. For the next four to five years, the gardens continued to flourish, but began to decline steadily as key members of the project took on other responsibilities outside the project, moved away for employment, or procured employment on the reservation. It was around the same time that gardeners began noticing the springs slowly retreating, one by one. By the summer of 2007 the

⁴³² Hopi man, interview by author, Kykotsmovi, Arizona, April 26, 2013.

⁴³³ Restoration of agriculture progresses," *Tutuveni*, 29 July 1993.

terrace gardens of Bacavi were no longer being cultivated. And by 2013 only one of the original five springs was discharging any discernable amount.⁴³⁴

While gardeners at Bacavi were observing the retreat of the five springs that once gave life to a canyon filled with chilies, sweet corn, and amaranth, men and women who spent childhood summers in the 1950s and 1960s tending the terraces of Wepo Springs began returning to the site after years of absence. What had once been a source of community life for plants and people alike was but a shadow of its former self. Tamarisk and Russian olive trees had overwhelmed many of the terraces, even taking over the grove of aspen trees that was the site of so many happy childhood memories.⁴³⁵ The terraces themselves were crumbling, and by the early 2000s less than a handful of families were still utilizing the area.⁴³⁶ The state of disrepair in which these men and women found Wepo Springs evoked a swell of emotions, deeply saddening them as exemplified by one woman's memory of returning to the site as an adult. She traveled to Wepo Springs, where she sought out places where she and her sister played as children, their favorite places. But she found that pieces of the landscape were missing, like the place where she and other children would play near the corn. "No longer," she recalled, were "our jack and the beanstalk beans growing anymore; and no longer the fruit trees; or our favorite spot on the rock

⁴³⁴ Hopi man, interview by author, Kykotsmovi, AZ, June 5, 2013.

⁴³⁵ For more on the history and ecology of tamarisk in the American West, see Anna Sher and Martin F Quigley, *Tamarix: A Case Study of Ecological Change in the American West* (New York, NY: Oxford University Press, 2013); Matthew K Chew, "The Monstering of Tamarisk: How Scientists Made a Plant into a Problem," *Journal of the History of Biology* 42, no. 2 (2009): 231–66; For Russian olive, see Liana K. D Collette and Jason Pither, "Russian-Olive (*Elaeagnus Angustifolia*) Biology and Ecology and Its Potential to Invade Northern North American Riparian Ecosystems," *Invasive Plant Science and Management* 8, no. 1 (2015): 1–14; Gabrielle L Katz and Patrick B Shafroth, "Biology, Ecology and Management of *Elaeagnus Angustifolia* L. (Russian Olive) in Western North America," *Wetlands* 23, no. 4 (2003): 763–77.

⁴³⁶ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

where we would sit and make pottery.” These places that played such an important role in her childhood at Wepo Springs “were just gone, they were missing.”⁴³⁷

The landscape had shifted along with the plants, animals, and people who had co-created it. The overwhelming sense of sadness felt by those returning to the site was stark and immediate. One woman spoke with me about the disappearance of “the little forest area” that she and other children once played in. Its absence upon her return deeply saddened her. “It was just gone,” she told me. “It made me cry.” There was not a single aspen tree where the grove had once stood, only tamarisk. “How could they neglect it?” she asked, explaining she thought families had taken care of Wepo Springs over the years. “But I guess over time,” she continued, “you grow up, you go to school.” Since there was no high school at the time, she and other students attended schools away from the reservation and then spent their high school summers looking for jobs. “We just kind of didn’t go back there,” she said sadly.⁴³⁸

Such emotion, coupled with a longing to return the site to its former state of productivity, propelled a restoration project not unlike the one that played out in Bacavi’s terrace gardens. Working with the Center for Sustainable Environments at Northern Arizona University and the Hopi Tribe’s Office of Range Management, former and contemporary gardeners of Wepo Springs restored the terraces and irrigation system. The spring was still producing, but it was “not as productive as it used to be” in the 1960s.⁴³⁹ Issues with water at the site constricted the restoration process as well as continued participation in agricultural activities at Wepo Springs. Significant subsidence was also occurring on the part of the mesa where the spring is located,

⁴³⁷ Louella Nasonhoya, interview by Kyrie Thompson, Flagstaff, Arizona, October 20, 2005.

⁴³⁸ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴³⁹ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

further complicating restoration efforts as a woman working on the restoration project in the early 2000s recalled:

Over years, I'm not sure if it was from the drop of the water level, or with just movement, or what, but the mesa fell, the rocks fell on top of the water. Once it fell on the water, it kind of squished the water. And the water, then it didn't have one natural flow, one main vein to follow anymore. When it became squished, it developed like fingers, because it squished. So now we've got little veins running all underneath the hill. Along the side of the hill, the water is running underground, and we're losing a lot of water. It's not being channeled directly into our water tank anymore.⁴⁴⁰

This part of the mesa has crumbled at least two different times, once around 2005 and again in 2012. The second time the mesa subsided, big boulders fell off and the area where the recently restored irrigation system is located was affected, likely crushing the pipe and constraining water flow.⁴⁴¹ When asked about the causes of subsidence, some equate the mesa collapsing with increased drought conditions on the reservation over the past decade, seeing it as a result of natural forces.

And all the springs that go down that side of the mesa feed off of that spring and so probably with just wear and tear and you know earth movement and whatnot. And it's been so dry, you know, the deterioration, it's bound to fall. I mean our whole mesa is doing that right now with just the intense heat and then when it rains, you know it cracks the rock and so you see large chunks of the mesa coming off and I think that's probably what's happening.... I don't think it's really lowering of the water table.⁴⁴²

Pinpointing the exact causes of changes in the hydrologic landscape of Hopi terrace gardens is difficult, if not entirely impossible. While some water users, like the gardener who spent childhood seasons helping her grandmother grow brightly colored beans in the high and

⁴⁴⁰ Louella Nasonhoya, interview by Kyrie Thompson, Flagstaff, Arizona, October 20, 2005.

⁴⁴¹ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴⁴² Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

narrow terraces of Bacavi canyon, may partially attribute the retreat of spring waters to industrial uses, others do not see activities such as industrial groundwater pumping contributing to the widespread observance of depleted discharge and subsidence. Despite the challenge of assigning causality, the ecological observations of Hopis are a valuable resource in understanding environmental change on the reservation. Changes like declining water resources or restricted access to water in these ancestral spaces limits the ability and willingness of Hopis to continue traditional agricultural practices. As one woman involved in the restoration at Wepo Springs explained, “While people may want to plant, if there’s no easy access to water, they’re not gonna do it.”⁴⁴³

In the village of Moenkopi, on the westernmost part of the Hopi Indian Reservation, farmers have tended irrigated fields for generations – one of the few places on the reservation where this type of agriculture occurs. Fed by a spring called Susungva, the fields of Moenkopi overflow with corn, melons, beans, and various other crops each summer. Those raised in the village during the 1960s recall the immense amount of water that would shoot from the galvanized steel pipe, two and a half inches wide, that served as the spring’s outlet into the irrigation system. “Growing up we used to go down there to Susungva,” explained one woman from Moenkopi. “The amount of water we had there would fill the diameter of that pipe and it would shoot at a distance.” The water, she recalled, would catapult nearly three feet from the pipe and then enter the small, earthen canals that feed the fields. Susungva still provides irrigation water to the farmers, but the discharge has declined significantly in the eyes of villagers. “It’s still running,” she continues. But the water only fills about a quarter of the pipe’s

⁴⁴³ Louella Nasonhoya, interview by Kyrie Thompson, Flagstaff, Arizona, October 20, 2005.

diameter now. It doesn't shoot out as it once did, but is a steady trickle. "That was really disappointing to me when I started seeing this about 10, 12, 13 years ago," she lamented. "It made me sad because I had all these fond memories of what it used to be."⁴⁴⁴

Some farmers in Moenkopi associate the decline of water from springs like Susungva with the pumping of groundwater by Peabody Coal Company. "Every spring that we have around here, along the valley here dried out" a farmer now in his eighties explains. "All the springs went out." Take, for example, the once beautiful Sa'lako, a spring located at the end of Pasture Canyon near the Hopi village of Moenkopi and a place where local knowledge of a water source was interwoven with oral tradition. There a curtain of water flowed over and then down a sandstone wall with finger-like cracks, creating a habitat for the water serpent that guarded the site. Underneath the spring was a big opening where Hopis had cleared out water drainage ditches. "They were pretty good at cleaning their ditches so they could have some water" the same farmer recalls. "That's when the reservoir was always full of water." During the 1940s and 1950s young boys would visit Sa'lako, making noise on their hike to the spring with the hope that any sunbathing serpents would jump back into the water before their arrival.⁴⁴⁵

While many never witnessed the water serpent with their eyes, the relationships formed with this sacred space persisted over the course of a lifetime, although visits to the site became less frequent as Hopis left the reservation first for boarding school and often pursued employment far away from home. When a farmer from the village of Moenkopi visited Sa'lako near the end of the twentieth century, he was overwhelmed with disbelief and sadness at what had become of his beloved Sa'lako. "During the drought," he explained, "The whole wall fell

⁴⁴⁴ Hopi woman, interview by author, Kykotsmovi, Arizona, April 26, 2013.

⁴⁴⁵ Hopi man, interview by author, Moenkopi, Arizona, November 7, 2013.

over.” “It looked so *awful*,” he continued. What remained of the spring site was covered in drifting sand dunes, and there was no water coming out of the spring. “I just couldn’t believe it! How can that happen? *What* happened?” wondered the farmer. When speaking with others he learned that after the spring wall had collapsed after a series of particularly windy years deposited sand dunes. “And it just covered up the whole thing. And it doesn’t look like Sa’lako anymore,” he said sadly. “It’s not like it used to look. I guess maybe just a few of us remember that. Some of them don’t know how it was. They don’t even know what Sa’lako is.”⁴⁴⁶ He mourned not just the loss of a sacred water source, but also an erosion of knowledge about the spring. His knowledge is rooted in both oral tradition and interactions with the water source.

Hopis who herded livestock historically and in the present also possess intimate knowledge of springs, as the survival of Hopi sheep and cattle depended on these resources for centuries. In the late twentieth century, Hopis began noticing springs they frequented in their youth and even into adulthood to water their livestock were drying up. On Third Mesa, a farmer who historically herded sheep in the Oraibi Valley recently returned to a place in Oraibi Wash where three springs once flourished. “They’re no longer discharging,” he explained. “Only remnants of some old brush” remained where the springs had been. The brush was in stark contrast to the resource he once relied upon that included not just three springs, but a “big swamp in one of them.” The wetlands had disappeared, much in the same way he had witnessed numerous smaller springs on the sides of the mesas dry up.⁴⁴⁷ He herded sheep in this area into the 1980s, and his decades of regular interaction with these springs as part of traditional Hopi herding practices provide him with local ecological knowledge that spans decades.

⁴⁴⁶ Hopi man, interview by author, Moenkopi, Arizona, November 7, 2013.

⁴⁴⁷ Hopi man, interview by author, Kykotsmovi, AZ, June 5, 2013.

Not far from this site, in Third Mesa's North Oraibi range unit, a cattle rancher whose family depended on a series of three springs for generations began noticing significant changes in the springs in the late 1990s. Utilizing the springs for both livestock and domestic consumption through the 1960s, this rancher and farmer still depends on spring water as part of his overarching water strategy for cattle ranching. During the 1940s and 1950s, his family relied on one particular spring for domestic consumption. "That spring used to be three-quarters full," recalled the farmer. "That has dried up completely within the past, I'm going to say, ten years now. There will be times when there's a slight resurgence of moisture around the base of it. But in the past five to six years that pond has not produced any drinkable water at all."⁴⁴⁸

This rancher and farmer found it odd that only one of the three springs has gone completely dry since it is "on the same level, same elevation as these other springs." Those other springs, both of them, are still producing but only "at a very minimal level," a change he began observing fifteen years before our conversation. He recalls the decline happening abruptly. The seepage from the spring his family used for domestic consumption "just all of a sudden dried up." It was producing very little and, hoping that increased maintenance would aid in its return, they cleaned it out. "We were careful not to dig much sediment from it," he explains. They initially saw "a good surge for a while, but not enough really to make a difference." Once the initial decline at the spring's mouth occurred, it got "worse and worse each year." The less water the springs produced, the more the farmer depended on windmills to water his livestock. When asked why he thought springs were retreating, he explained that it was a lack of moisture related to both drought and "the depletion of the various aquifers for various reasons."⁴⁴⁹ This

⁴⁴⁸ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

⁴⁴⁹ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

multicausal explanation is quite common amongst farmers and ranchers throughout the Hopi Indian Reservation, as are similar observations in the behavior of springs.

Hopis residing and working on Second Mesa also began to notice springs drying up. One rancher and farmer who grew up in Mishongnovi during the 1960s remembers the village having six springs along the mesa cliffs. “Right now there’s probably only one that’s being used,” he explains. The other five springs? “No,” he tells me. “They’re all dry.” He believes that a lack of precipitation is to blame for the springs’ retreat in Mishongnovi. “We weren’t getting the moisture,” he says. “The springs weren’t being filled to what they used to. They just quit running.”⁴⁵⁰

Hopis from First Mesa, where villages like Walpi once depended on spring water, also observed shifts in groundwater resources near the end of the twentieth century. One Hopi recalls a spring on the northeast side of Walpi, about halfway down the mesa, that is now completely dry.⁴⁵¹ A farmer from Walpi who now lives in Polacca echoes this sentiment, putting forth a multicausal theory for the recession of groundwater. “There’s a lot of the springs that have little or no water,” he explains. “And it takes a long time before you see water back in the springs. There’s a big change.” He believes that a lack of rains is contributing to a problem for which coal development is at least partially culpable. “I worked in the coal mine, too,” he explains to me. “And I know what they did with the water...to transport the coal slurries. So I believe that. I think they’re overusing the abundance of water that’s being pumped from the ground. It’s affecting our springs here.”⁴⁵²

⁴⁵⁰ Hopi man, interview by author, Kykotsmovi, Arizona, April 26, 2013.

⁴⁵¹ Hopi man, interview by author, Flagstaff, Arizona, October 9, 2013.

⁴⁵² Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

A farmer and rancher who worked for the Hopi Tribe's Water Resources Program during the 1980s and 1990s also presents a multicausal theory to explain the lowering of the water table. As part of his work, this agriculturalist and day laborer inspected both windmills and springs. By the late 1980s he began noticing a decline in the discharge of some springs. When this happened, Hopis working for the Water Resources Program would clean out the springs and then measure the rate of recharge. "Some of the springs were doing pretty good," he recalls. "But some of them weren't, really. Like up in the northern area, the springs were okay. But it seemed like the springs down in the south area were not recharging as fast." He believes that industrial pumping of Hopi groundwater and a drastic increase in the number of domestic wells being drilled on Black Mesa by the Navajo Tribe are to blame. "They're depleting the water beneath us," he explained to me. "That's what's causing the water table to be lower."⁴⁵³

Much in the same way that those involved in terrace gardening were and are particularly prescient in their observations of these resources, so too are ranchers who depend on both surface and groundwater for the survival of their livestock. And like their gardening counterparts, ranchers have much to lose when water sources disappear, threatening traditional agricultural practices with their departure. The federal government and the Hopi Tribe have spent countless years and millions of dollars developing water resources for Hopi ranchers. Over the course of the twentieth century and into the twenty-first, water infrastructure for Hopi livestock expanded to include surface water impoundments along with developed groundwater sources including springs, wells, and windmills. In a land where rain is scarce and drought is ever persistent, groundwater resources, particularly windmills, have become increasingly important to Hopi ranchers and the animals in their care. These resources, however, are becoming increasingly

⁴⁵³ Hopi man, interview by author, Kykotsmovi, Arizona, August 6, 2013.

scarce. And, much in the same way that farmers and gardeners understand the probable causes of a declining water table, ranchers present explanations that are sometimes singular and more often multicausal. Whatever the cause, the implications of depleted groundwater out on the range are at once clear and critical. Conflict over water, coupled with an increasing inability to pursue ranching as it has been practiced at Hopi over the past century, is rapidly changing husbandry practices in this fragile environment.

Hopi ranchers depend on a variety of water resources for the successful maintenance of their herds. Wells powered by windmills became increasingly central to Hopi husbandry practices over the course of the twentieth century, and today are critical sources of water for Hopi cattle throughout the reservation. Beginning in the late 1980s ranchers began noticing declining water levels in the windmills.⁴⁵⁴ Over the next two decades more and more problems started to appear with the windmills, complicated by increased domestic and industrial pumping, long term drought conditions, and limited tribal funding for maintenance.

By the beginning of the twenty-first century, windmills across the reservation were breaking down. As water levels dropped, silt began accumulating in the windmills often breaking the pumping mechanism down at the bottom.⁴⁵⁵ As the former Water Resources Program employee explained, “The silt prevents the water from going into the area where it needs to be pumped out.”⁴⁵⁶ To rectify the problem, technicians clean out the silt and often add additional rods to the windmill, drilling deeper into the earth to reach the groundwater.⁴⁵⁷

⁴⁵⁴ Hopi man, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴⁵⁵ Hopi man, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴⁵⁶ Hopi man, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴⁵⁷ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

For ranchers who have witnessed the addition of multiple rods to windmills upon which their livestock depend, this type of maintenance serves as a record of the hydrologic change they have observed over the past decade or more. Take, for example, the experience of a rancher from Third Mesa. When I interviewed him in the summer of 2013 he explained that over the past five years an additional five rods have been added to the windmill he utilizes. The windmill's well is now "about a hundred feet deeper than what it was" five years ago.⁴⁵⁸ Ranchers throughout the reservation are having similar experiences. Some windmills, even after repair, are barely producing enough water to fulfill the needs of ranchers while others have stopped working completely.⁴⁵⁹

Some Hopis believe that a lack of rainfall is responsible for declining water tables and hence broken windmills, others think that groundwater depleted in the past by mining operations or presently by the increased domestic use on both the Hopi and Navajo Indian reservations is to blame. Assigning causality to issues of sedimentation within the windmill wells themselves is also complicated, with some linking a lack of water to malfunctioning pumps while others see high winds and associated dust storms as the culprits. Most, ranchers I spoke with, however, told me that the increased necessity of maintenance coupled with a lack of tribal resources to perform such maintenance is complicating the issue. As one former range technician put it, "Our programs don't have the funding anymore. We're lacking personnel. They're not maintained. A lot of the windmills are down."⁴⁶⁰

Decreased rainfall is adding new pressures to groundwater sources like windmills as ranchers have a less diversified set of option for maintaining their herds. In the past, ranchers

⁴⁵⁸ Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

⁴⁵⁹ Hopi woman, interview by author, Kykotsmovi, Arizona, July 31, 2013.

⁴⁶⁰ Hopi man, interview by author, Kykotsmovi, Arizona, April 24, 2013.

were able to rely more upon surface water impoundments, often referred to as earth tanks or dirt tanks, to fulfill their livestock's water needs. These sources have become increasingly unreliable over the past two decades, putting even more pressure on windmills and artesian wells developed on Hopi rangeland. If the rains don't fall, the earth tanks don't fill. As a Third Mesa rancher explained, "There's no water in them. I would say fifteen years ago I used to be able to maintain that whole range area. I'd even shut down the windmill because I wanted the cattle to utilize the whole range area and there'd be water in those dirt tanks out there. I haven't seen that in the past fifteen years."⁴⁶¹

This lack of surface water combined with malfunctioning windmills facilitated a major shift in the way ranchers provide water for their livestock, putting pressure on community resources in the process. Ranchers without access to water in windmills or earth tanks are resorting to hauling water to their herds. "We've got people hauling water all over the place here on the Hopi reservation to make sure the livestock have enough," explained a Second Mesa woman who has been ranching since around 2005.⁴⁶² The scarcity of water not only puts pressure on functioning windmills and community wells, but also on the ranchers themselves. For Hopi ranchers who are also employed outside their agricultural pursuits, hauling water has become akin to working a second shift. In the summer of 2008 a Second Mesa rancher had to haul water to his cattle every evening because the earth tank upon which his family has depended for several generations failed to fill and maintain a water level sufficient to support his herd. In response, he bought a 400-gallon water tank that he would fill at the windmill each night when he got off work. By the time he arrived at the earth tank, it was 6:30pm and he would not arrive home until

⁴⁶¹ Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

⁴⁶² Hopi woman, interview by author, Kykotsmovi, Arizona, July 31, 2013.

nearly 9:00 each night.⁴⁶³ By the summer of 2013 ranchers were still hauling water. Take, for example, this Third Mesa rancher's daily routine during the month of June. "I've been hauling water for the last three months. Every day," he explains. "I got up at five, hauled one tank of water and then took a shower and came to work. So three hours already and I'll probably donate another three hours this evening."⁴⁶⁴

The utilization of water from domestic community sources by ranchers who have little choice but to haul water to their herds is facilitating conflict within communities about who should have access to such precious resources. By the summer of 2012 Hopi villages began witnessing an increase in livestock owners filling tanks with water from hoses right outside their home, from community institutions such as the Hopi Veterans Memorial Center, or from windmills historically used for domestic consumption.⁴⁶⁵ "It became a big problem," explained one natural resource manager.⁴⁶⁶ In response a group of Hopis drafted a letter to all community members stating that domestic water resources were not to be utilized for livestock. Eventually the tribe's range management program designated two windmills from which ranchers could fill their tanks, creating a temporary solution to the problem.⁴⁶⁷

If the monsoon rains come, the earth tanks will fill up and possibly grant a two or three month reprieve from hauling water.⁴⁶⁸ The stress and conflict created by dwindling water resources, however, is causing some Hopis to abandon ranching practices altogether – a trend that is likely to continue as drought conditions persist. "A lot of people have dropped out,"

⁴⁶³ Hopi man, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴⁶⁴ Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

⁴⁶⁵ Hopi man, interview by author, Kykotsmovi, Arizona, April 26, 2013.

⁴⁶⁶ Hopi woman, interview by author, Kykotsmovi, Arizona June 5, 2013.

⁴⁶⁷ Hopi woman, interview by author, Kykotsmovi, Arizona June 5, 2013.

⁴⁶⁸ Hopi woman, interview by author, Kykotsmovi, Arizona, July 31, 2013.

explained one natural resource manager. “It was a hardship hauling water. The water resources out there – they’re not plentiful like they used to be. And the upkeep on the windmills hasn’t been happening. It’s been a hardship for a lot of people.”⁴⁶⁹

The hardships wrought by drought are a familiar force for Hopi dry farmers, some of who are also resorting to hauling water as an adaptive strategy. The practice has increased since 2010 and has put additional pressure on groundwater resources. As one natural resource manager explained in 2013, “Over the past three years I know that a lot of farmers have been hitting the windmills because it’s been so dry. Just to help their plants along, they’ve been pulling water from the windmills – which they don’t normally do – and going out and actually watering their plants.”⁴⁷⁰ While Hopi corn has evolved over the past thousand years to the local environment and is traditionally dry farmed with no irrigation, extended drought conditions over the past decade have precipitated practices of hand irrigation. Some farmers are hauling water to dry farmed fields of corn and irrigating parched crops in the hope that their fields might be salvaged. “I think it’s just the feeling that we have for our corn plants,” explains a First Mesa farmer. “When you go out there in the summertime during the drought seasons and you see them just hanging there about to dry up – shriveled up – you feel sorry for your corn.” The practice of irrigating dry farmed crops, however, concerns him. “We know it’s gonna change the corn plant’s system because then next year they’re gonna want more water,” he explains. “See, they’re accustomed to the dry seasons and they’ll survive somehow. But if we go out there and see our plants just being in a poor state – just practically drying up, all shriveled up – then, yeah.

⁴⁶⁹ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

⁴⁷⁰ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

Some farmers will come and bring in their water tanks.”⁴⁷¹ Others criticize this practice as a departure from traditional Hopi ways of farming, which are rooted in a culture of faith, hope, and persistence despite weather conditions. “That’s not the way you do it,” explains another First Mesa farmer. “It’s through your faith and your participation in ceremonies and prayer and being out there and interacting with these children, the corn.”⁴⁷²

Hand irrigation, however, does not necessarily result in a bountiful harvest. One Third Mesa farmer recalled a particularly dry season in the 1990s where he did not grow anything. “It was a sad time for me because I’m not used to that,” he explains. “I planted but it just didn’t grow. I even took a water barrel to try to put water on the plants there at my field and it didn’t help. It was so hot and dry that year that we just didn’t grow anything.”⁴⁷³ Yet it is the desire to produce something, anything, in times of drought that motivates some to irrigate. “If they’re not doing it, they’re tempted to water dry farming plants,” mentions another agriculturalist. “I don’t think anybody wants to admit it because that’s aside from our practice. But I think it’s happening just to assure that they get something out of it in the end.”⁴⁷⁴

Like gardeners and ranchers, dry farmers are dependent on water for the successful continuation of their agricultural practices and are uniquely positioned to delineate ecological change over time. Because of the centrality of rain to both their agricultural and spiritual practices, Hopi farmers are astute observers of shifts in climate and weather. Many have lived and farmed in the same places for their entire lifetime with brief exceptions of sojourns away from home for school or employment. As such these men and women have noticed significant

⁴⁷¹ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

⁴⁷² Hopi man, interview by author, Flagstaff, Arizona, October 9, 2013.

⁴⁷³ Hopi man, interview by author, Kykotsmovi, Arizona, November 7, 2013.

⁴⁷⁴ Hopi woman, interview by author, Kykotsmovi, Arizona, July 31, 2013.

changes in weather patterns over the course of their lifetime, many of which are affecting their ability to continue farming in the way of their fathers and grandfathers. These observations are critical to understanding the local scope and implications of global climate change in a geographically and culturally specific context.

Growing up in the 1960s, many Hopi children heard their parents and grandparents speak of times to come when moral and ecological forces would converge, forcing seasons out of sync and farmers to plant before the season of spring had arrived. These prophecies are vividly remembered by those who grew up during this time period and still serve as an entry point into discourse concerning changing climatic conditions on the Hopi Indian Reservation. A woman who grew up in the village of Moenkopi recalls such a prophecy as told by her father when she was but a child. “There is going to come a time,” he explained. “The old people say that when we go to plant we are going to be planting with our jackets on because the seasons will become so distorted.”⁴⁷⁵ A Second Mesa man learned a similar prophecy from village elders during the same period. “There will come a day when we don’t watch what we’re doing,” his grandfather told him. “We’ll be planting in the snow,” he continued. “You’re gonna have to brush that snow away to plant.”⁴⁷⁶

These prophecies reveal a foresight into changing climatic conditions as well as an association between disrupted ecological cycles and a shift away from traditional Hopi ways of living and planting toward more modern lifestyles. When asked why particular environmental issues, such as the shifting of seasons or the drying up a scared spring, are occurring, many Hopis with whom I spoke associated such changes to larger cultural changes such as a decline in

⁴⁷⁵ Hopi woman, interview by author, Kykotsmovi, Arizona April 26, 2013.

⁴⁷⁶ Hopi man, interview by author, Kykotsmovi, Arizona, April 26, 2013.

farming, an increase in drug and alcohol use, or a focus on the material, monetary world. As the prophecies suggest, not living the Hopi way may lead to larger environmental changes such as decreased precipitation, violent dust storms, drought, or the disappearance of seasons altogether. Hopi farmers and their families are careful observers of these changes, providing details that climate and weather data alone cannot tell us.

Successful dry farming on the Hopi Indian Reservation is dependent on ample precipitation at critical points in the agricultural calendar. Snow, in particular, is exceedingly important to the overall success of dry farmed crops as such moisture, combined with spring rains, provides sustenance for crops of corn, beans, and squash for the several months between spring planting and the arrival of monsoon storms in mid-late summer. “Every year,” explains one Third Mesa man, “we as farmers take a look at the snowfall. We’re not getting the kind of storms we used to get.”⁴⁷⁷ Farmers recall winters where snow fell at a much higher rate. As one man states, “I remember walking every winter through snow. We don’t see much snow anymore. For a few years it was just warm all the way until maybe February. Then we’d finally get cold and get snow. But even December was like fall weather.”⁴⁷⁸ Winters have become shorter.⁴⁷⁹ And many recall seasons of snowfall that were quite different from those of recent years on the Hopi mesas. “It seems like we just get a dusting,” explains one woman. “When I was growing up we used to have two to three feet of snow that would last a week.”⁴⁸⁰ She remembers these snowstorms as regular occurrences during the 1970s and 1980s.

⁴⁷⁷ Hopi man, interview by author, Kykotsmovi, AZ, June 5, 2013.

⁴⁷⁸ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

⁴⁷⁹ Hopi man, interview by author, Kykotsmovi, Arizona, June 5, 2013.

⁴⁸⁰ Hopi woman, interview by author, Kykotsmovi, Arizona, July 31, 2013.

For some, it is not just the quantity of snowfall that seems to have changed but rather the snow itself. As one farmer puts it, “The snows aren’t the right type. The wet snows and dry snows have a lot to do with it.”⁴⁸¹ A Third Mesa farmer agrees, explaining the importance of assessing not only how the snow looks, but also how it feels. “I look at the texture of the snow,” he explains. “You can always be hopeful, always wishful that it would be a good, wet snow that would come and can give us a good layer and then fall, not freeze.”⁴⁸² Yet since around 2010 he has noticed that snowfalls have been followed by “a pretty heavy cold fog situation” wherein “that fog will suck up that moisture.”⁴⁸³ He wonders if there isn’t a spiritual aspect to it – that perhaps it’s a sign we are not entitled to the moisture because the human race is too focused on money, including Hopis themselves.⁴⁸⁴

Whether or not farmers are morally entitled to the moisture falling on the Hopi mesas, the importance of receiving adequate snowfall is clear as one natural resource manager explained. “What the ground out here really needs is that snow,” she says. “Because it’s that snow that gives is that moisture layer.”⁴⁸⁵ What she is referring to is the layer of moist soil underneath the sandy alluvial soil. This gives plants life until the summer monsoon storms arrive. In the past the layer of moist soil was usually between 12 and 16 inches from top to bottom, and this was the layer in which farmers planted their seeds. Beginning around 2010 range management technicians measuring soil moisture found that this layer of moisture had diminished significantly. “They said that at most it’s probably about a good inch to half an inch of moisture,” she explains. “Everything is just that dry.” In order to reach this narrow layer of

⁴⁸¹ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

⁴⁸² Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

⁴⁸³ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

⁴⁸⁴ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

⁴⁸⁵ Hopi man, interview by author, Kykotsmovi, Arizona, August 6, 2013.

moisture, technicians had to go at least sixteen inches deep before reaching it and in some areas it was still dry at that level.⁴⁸⁶

The implications of this shift in pre-planting soil moisture for dry farmers can be significant. Some farmers are planting multiple times because their corn does not come up – the dry soil may be preventing the seeds from germinating.⁴⁸⁷ This lack of germination worries farmers and some who find dry soil take water to the field with them. After digging the hole into which the seeds will be planted, some put a cup of water on top the seeds, cover them with soil, and then pour water on top of it, “just to get it to start to grow.”⁴⁸⁸

Such problems are more pronounced as decreased winter moisture is coupled with colder temperatures that extend into the spring. One farmer who grew up in the 1940s thinks the shift is significant. “Way back it used to get warm right away,” he explains. “And we started planting early, like in April, even March.” He remembers spring as a warm season, but now he says it could even snow in May. This has serious implications for crops already put in the ground. “When he gets cold,” he goes on, “the seeds – the corn, melon – those seeds, they can’t sprout. They can’t sprout till they get warm.”⁴⁸⁹ Many associate this lingering of winter and late arrival of spring with decreased germination. A Third Mesa farmer who always plants on his birthday – April 12 – remembers the weather being nice and the season suitable for the planting of early corn. While he still plants on his birthday each year, he has noticed a change in the plants’ growth cycles. “The seeds stay dormant for a long time because it basically isn’t warm enough

⁴⁸⁶ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴⁸⁷ Hopi woman, interview by author, Kykotsmovi, Arizona, July 31, 2013.

⁴⁸⁸ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴⁸⁹ Hopi man, interview by author, Kykotsmovi, Arizona, April 16, 2013.

for them to germinate,” he explains.⁴⁹⁰ When it used to take about two weeks for the seeds to germinate, now it takes much longer for the corn sprouts to emerge from the soil.⁴⁹¹

While some farmers continue to plant early corn in April, even if it means wearing winter coats as the prophecies suggest, others delay their planting until the weather warms up.⁴⁹² When a farmer plants early corn affects whether or not it will be ready for harvest by the time of the Home Dances in July.⁴⁹³ For example, in 2013 the ground remained frozen in many places when it came time for the early planting. As a result some farmers did not plant until June. As one natural resource manager explained, this impacted an important cultural event that July.

It used to be that by the time we had our Home Dances out here that at least some of the fields would have some corn in it. You could take your own corn up on the mesa and the kachinas could use that. But this time around our plants didn't have any corn on them. So I don't think there were too many people that got their own corn up there to use. I know that a lot of them were heading down to Camp Verde to go get corn. But even then I noticed when they brought the stalks from there, that some of the people were having to tie corn onto the stalks because the corn on the stalk ... weren't fully matured.⁴⁹⁴

A lack of mature early corn for the Home Dance is one example of how changes in climate on the Hopi Indian Reservation are affecting social and cultural processes that have been in place for generations. Rather than being able to produce enough of their own early corn to be used in the Home Dance, the farmers to whom this natural resource manager refers had to drive several hours south into the Verde Valley to acquire corn to be used in the dances. This signifies

⁴⁹⁰ Hopi man, interview by author, Kykotsmovi, AZ, June 5, 2013.

⁴⁹¹ Hopi man, interview by author, Kykotsmovi, AZ, June 5, 2013.

⁴⁹² Hopi man, interview by author, Kykotsmovi, Arizona, April 26, 2013.

⁴⁹³ For descriptions of the Home Dance, see Clemmer, *Roads in the Sky*, 17; Mischa Titiev, *The Hopi Indians of Old Oraibi: Change and Continuity* (Ann Arbor: University of Michigan Press, 1972), 5–6; Helen Sekaquaptewa and Louise Udall, *Me and Mine: The Life Story of Helen Sekaquaptewa* (Tucson: University of Arizona Press, 1969), 66.

⁴⁹⁴ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

both a change in the material nature of a cultural event as well as an adaptation to shifting climatic conditions on the Hopi mesas. The late arrival of spring, then, helped facilitate a larger change in the way corn, a cultural resource, is procured for use in a culturally significant event like the Home Dance.

In addition to planting later, the delayed onset of spring also affects biodiversity in the fields. A Third Mesa farmer explains:

It's getting to the point where we're planting either later or we're just not planting some of the different seeds that normally requires that ninety to a hundred and twenty day growth span. Some people have given up on that because it's just not maturing. There's a certain kind of variety of beans that takes a lot longer to mature. I would say the pumpkins and gourds are something that's not being planted like how they used to be.⁴⁹⁵

Like the absence of early corn for the Home Dance, a decline in the planting of specific cultivars that require a longer growing season is a serious implication of shifting climatic conditions on the Hopi Indian Reservation. Over the long term, such trends could become more common and lead to critical changes in the varieties of crop being planted by Hopi farmers. In this sense a delayed planting season facilitated by changes in weather has the potential to impact agrobiodiversity and the local food system as a whole.

Yet it is not just the lingering of winter that farmers have begun noticing in terms of shifts in the weather. Many speak of the season of spring simply having “been missing” over the past decade. “It gets skipped over real quick,” explains one woman. And then the season rapidly shifts into summer.⁴⁹⁶ “We were still in April, May – kind of like freezing – and then it got

⁴⁹⁵ Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

⁴⁹⁶ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

warm,” tells another farmer. “And then it got really, really hot...real fast.”⁴⁹⁷ Such an abrupt change in temperatures has many Hopis worried as the mercury keeps rising and farmers find themselves contending with above average heat well before the monsoon storms arrive.

In addition to shifting seasonal temperatures, Hopis are also contending with violent winds that last well beyond the spring season in which they were generally contained in the past. With the exception of decreased precipitation and groundwater, Hopis I interviewed discussed the increase in winds more than any other ecological change observed of the course of the twentieth and twenty-first centuries. “The weather patterns have changed dramatically since the 60s and 70s,” explains one farmer. “Today is June 10th and these winds I normally don’t see except in early spring. And it’s blowing like crazy out there right now.”⁴⁹⁸ The season for winds has shifted, as another farmer explains. Winds usually come around March and stay through April, perhaps into May. “But now it blows from January all the way up to June,” he tells me. “It dries up the soil the snow brings.”⁴⁹⁹ Not only does it dry out the soil, he says, but it also blows away precious topsoil and brings in invasive weeds that drink up valuable water. Such strong winds have serious implications for farmers as they contribute to erosion. “I notice that in my field,” explains another farmer. “A lot of soil has been blown away – top soil.”⁵⁰⁰ The strong winds, he thinks, are working together with the widespread use of tractors to facilitate this erosive process.

It is not only the frequency and energy of these winds that Hopis are observing. Some have noticed that the wind directions themselves are changing – a shift they see materialized in

⁴⁹⁷ Hopi man, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁴⁹⁸ Hopi man, interview by author, Hotevilla, Arizona, June 10, 2013.

⁴⁹⁹ Hopi man, interview by author, Kykotsmovi, Arizona, July 31, 2013.

⁵⁰⁰ Hopi man, interview by author, Kykotsmovi, Arizona, November 7, 2013.

the location of sand dunes that are forming in places they previously did not exist. “I noticed that the wind is blowing different ways now,” explains a farmer now in his eighties. “It’s not the way it used to be. I’m not the only one that noticed that.”⁵⁰¹ Around 2010 many began noticing these major shifts in wind patterns. “These winds have gotten huge,” says a Second Mesa farmer. “I’ve never seen windstorms like that before. They last for a whole month.” He recalls a storm within the past few years that lasted for a month, building up sand dunes along the roads that had to be cleared up. The range, he explains, looked like it was overgrazed because all the plants were covered in sand. He believes that the increase in wind and the associated dust storms are poor air quality, aggravating the symptoms of those with asthma and other respiratory diseases. It also affects how farmers and ranchers work as the dust, it turns out, gets in your eyes. “A lot of times you can’t really be out doing work,” he explains.⁵⁰²

Along with dust storms have come tornadoes, something that many Hopis with whom I spoke with see as a new and frightening twist in weather patterns on the mesas.⁵⁰³ “We never thought or heard of tornados,” explains one Hopi woman. It wasn’t until around 2000 that she or

⁵⁰¹ Hopi man, interview by author, Moenkopi, Arizona, November 7, 2013.

⁵⁰² Hopi man, interview by author, Kykotsmovi, Arizona, April 24, 2013.

⁵⁰³ For more on the history and climatology of tornadoes in Arizona, see Craig Shoemaker et al., *Hazardous Weather Climatology for Arizona* (Salt Lake City, UT: U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Scientific Services Division, Western Region, 2008), <http://purl.fdlp.gov/GPO/gpo9680>; David O. Blanchard, “A Comparison of Wind Speed and Forest Damage Associated with Tornadoes in Northern Arizona,” *Weather Forecasting* 28 (2013): 408–17; Robert S. Ingram, *Arizona “Eddy” Tornadoes*, NOAA Technical Memorandum ; NWSTM WR-91 (Salt Lake City, Utah: U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Western Region, 1973); For analyses that address possible and historic societal impacts of tornadoes, see Theodore Steinberg, *Acts of God: The Unnatural History of Natural Disaster in America* (New York: Oxford University Press, 2000); Kevin M. Simmons and Daniel Sutter, *Economic and Societal Impacts of Tornadoes* (Boston: American Meteorological Society, 2011).

her family members witnessed a twister.⁵⁰⁴ “In my lifetime I’ve never, never witnessed tornadoes,” explained a Third Mesa farmer. “But now – regularly – we’re spotting them and they’re actually forming out of these huge summer monsoon storms.”⁵⁰⁵ These kinds of storms were never around before, he continues, and he has no idea how to explain it. It could be, he posits, related to the fact that “we’re getting more vicious thunderstorms” that “have enough energy to produce tornadoes.”⁵⁰⁶

Changes in the intensity and pattern of storms and the type of rain that reaches farmers’ fields are prescient observations that form a central component of Hopi discourse on changing environmental conditions on the reservation. One observation that stands out is the shift in reliability and timing of storms once monsoon season has started.⁵⁰⁷ “You could pretty much set your clock to it,” explains one farmer who is also a natural resource manager. “At a certain time in the afternoon it would start raining somewhere and it hasn’t been like that for a long time.”⁵⁰⁸ When it does rain, the types of storms are quite different from what many remember. One farmer from Third Mesa refers to a certain kind of storm as a “cloudburst” where the rain comes in a tremendous downpour. “It just rained so much, so fast,” he explains, “that the water had to go downhill. It didn’t go into the ground as much as we’d like it to.”⁵⁰⁹

This increase in violent rainfall is a marked shift in the minds of many Hopis, who recall rains for the majority of their lives as gentle precipitation that would fall slowly and soak into the

⁵⁰⁴ Hopi woman, interview by author, Kykotsmovi, Arizona, April 26, 2013.

⁵⁰⁵ Hopi man, interview by author, Kykotsmovi, Arizona, June 5, 2013.

⁵⁰⁶ Hopi man, interview by author, Kykotsmovi, Arizona, June 5, 2013.

⁵⁰⁷ Hopi man, interview by author, Kykotsmovi, Arizona, April 12, 2013.

⁵⁰⁸ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

⁵⁰⁹ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

ground.⁵¹⁰ “I remember when we got our monsoons that they were drizzle and they would last for hours. It was a slow drizzle. First it would moisten the top of the soil and then it would... start sinking in,” recalls a Second Mesa woman who is also a natural resource manager. Now, she explains, the soil is so compact from drought conditions that when the violent rains arrive it runs off into the washes, often causing flash flooding that destroys crops.⁵¹¹ This process is impacting the ability of farmers to continue cultivating land that has been farmed by their clans and families for generations. “A lot of people, I think, have kind of given up. We used to have a lot of plots along the washes,” she explains. “But with the intense rains that we’re getting and the flash floods...the fields along the washes, they just get washed out. And so over the past three to four years they’ve quit planting along the wash system.”⁵¹²

An increase in violent rains also affects ranchers. One rancher and farmer from Third Mesa believes the shift in the type of rain falling on the Hopi Indian Reservation is affecting livestock forage, as plants respond differently to different types of rain. He explains how this knowledge and way of observing the rain’s effects was passed down to him from his father:

The grass availability has gone down considerably and primarily due to the lack of type of rain that we get. My Dad used to say, ‘When it rains, observe the after effects.’ There are times when you would get a good drizzle and the grass would notice it right away. And there are times you get a fairly heavy rain and what you would get is a crusting of the topsoil. So there is a difference. And, you know, I didn’t really realize that until you make yourself look at the soil, feel the soil, travel on the soil, walk the soil, to begin to notice some of these changes in the abundance of the vegetation was that they didn’t grow as hearty.⁵¹³

⁵¹⁰ Hopi woman, interview by author, Kykotsmovi, Arizona, April 26, 2013.

⁵¹¹ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁵¹² Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁵¹³ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

This farmer's observations of the effects of different types of rain on plants and soil are rooted in a cultural tradition and dependency on rainfall that, as his words demonstrate, have worked to maintain an ecological knowledge base over multiple generations. Such knowledge about rain is passed from one generation to the next, making observations about changes in its nature a valid source of scientific knowledge. One farmer from Third Mesa who grew up in the 1970s and 1980s explains differences in types of rains, how the time of day they fall matters for plants and soil, and how rain has changed over the course of his lifetime.

I can recall from my boyhood it used to rain a lot – the kind of rain that Hopis pray for, the gentle rain. It is just like a mist or drizzle – you know, a light drizzle, which doesn't come down real fast so it has a chance to soak into the ground.⁵¹⁴

This farmer not only observes a change in the type of rain that now falls on the Hopi mesas, but also the benefits of nighttime rains which now rarely occur. “My grandfather used to talk about how beneficial it is for the ground when it rains at night,” he explains. “It has that coolness and the time to kind of soak into the ground before the sun comes up and heats it and evaporates everything away.”⁵¹⁵

Another shift in monsoon patterns Hopis are observing is what one natural resource manager refers to as “strip rain,” which is quite different than the storms of her childhood. “Not all the land base gets touched by the weather systems that come through,” she explains. “The guys [range technicians] call it strip raining or strip snowing because it only goes through a certain area.” One range unit, for example, might receive a lot of rain or snow, she says. “But you go to the next range unit and that thing is bone dry.”⁵¹⁶ This differs from storms of her past.

⁵¹⁴ Hopi man, interview by author, Kykotsmovi, Arizona, July 31, 2013.

⁵¹⁵ Hopi man, interview by author, Kykotsmovi, Arizona, July 31, 2013.

⁵¹⁶ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

Then the monsoons “would just come in and moisten the whole area and the whole area would green up. But now you don’t see that,” she explains. “You see just patches of our land base greening up.”⁵¹⁷

It is not only the type of rain or the nature of monsoon storms that Hopis argue have changed significantly since the beginning of the twenty-first century, but the direction from which these storms come. Farmers now in their seventies and eighties recall elders during their childhoods teaching them about the directions from which the storms come. Then, they remember, storms made their way to the Hopi mesas not from the east, but from the southwest – from the direction of the San Francisco Peaks near Flagstaff, Arizona.⁵¹⁸ Around 2000 the storm directions began shifting, first west, then northwest, and finally to the east. “All of a sudden we started to get strange wind patterns from the east and that’s where it’s been coming from in the past few years. This is, to me, very unusual for the rains to be coming from the east,” explains a Third Mesa farmer.⁵¹⁹

Despite the fact that monsoon storms continue to make appearances on the Hopi mesas, most Hopis agree that drought conditions have been increasing over the past several decades, interspersed with seasons of increased precipitation. “When I was growing up,” recalls one First Mesa farmer, “rainclouds were constantly here. We had good rain.” He believes that decreased rainfall may be facilitating a decline in farming. “That might be another reason why people don’t farm as much – because of the dry seasons we have now,” he continued. “In the past maybe 10, 15 years clouds would come but no rain. And then they would just dissipate.”⁵²⁰ Other farmers

⁵¹⁷ Hopi woman, interview by author, Kykotsmovi, Arizona, August 6, 2013.

⁵¹⁸ Hopi man, interview by author, Moenkopi, Arizona, November 7, 2013.

⁵¹⁹ Hopi man, interview by author, Kykotsmovi, Arizona, November 6, 2013.

⁵²⁰ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

echo this sentiment, explaining that the choice to not plant in a given year is sometimes dependent on the amount of moisture. “We don’t want to waste the seed,” explained one farmer, “so we just let it go for a year.” For his family, this has been happening more frequently in recent years and he sees it as a trend in other communities as well. “It never used to be like that,” he continued. “Every year we would be out there planting. These last four years it’s been really dry and all the wind just dries out the soil.”⁵²¹

The sentiments of these farmers coupled with their observations of changing weather patterns demonstrate the delicate balance of dedication and reliable water resources that are central to the continuation of agricultural practices on the Hopi Indian Reservation. As their stories suggest, stress on water resources has resulted in the decision or lack of ability to not continue traditional agricultural practices in a changing environment. What is evident are the very real implications of declining water resources on traditional Hopi agricultural practices including the inability to irrigate ancestral terrace gardens, conflict between ranchers over water resources, and farmers having to plant late or not at all because of undesirable weather conditions.

Determining the causes of unreliable rain, dried up springs, or irrigation systems that no longer produce the amount of water they once did is complex and outside the scope of this project. Was it the pumping of billions of gallons of Hopi groundwater? Did the tamarisk and Russian olive trees invade the springs and deplete the ability to water terraces filled with vegetables grown for generations? Are prolonged drought and a disruption of snow and rainfall patterns to blame for the springs’ stair-stepped recession? Are the rains not falling because, as some Hopis claim, their people are not living the way in which Hopis should with respect to both

⁵²¹ Hopi man, interview by author, Kykotsmovi, Arizona, August 2, 2013.

the seen and unseen worlds? On the Hopi mesas, each explanation is plausible. When examined collectively and within the agricultural context from which they originate, these differing explanations illuminate the difficulty of assigning causality to a single factor. They also demonstrate the complexity and multiplicity of causal perceptions that can emanate from a series of similar socioecological experiences lived by different persons.

What Hopi agriculturalists with whom I spoke did agree on, however, is that both groundwater and surface water available for gardening and ranching have declined. The rains and adequate soil temperatures upon which Hopi dry farmed crops depend have become unpredictable and the seasons erratic. These shifts in climate and water resources are limiting the ability of some agriculturalists to continue Hopi traditional lifeways. Their stories of witnessing ecological change over time and local knowledge of resources are critical to gaining a multifaceted understanding of contemporary resource issues and adaptation to climate change.

CONCLUSION

On a Saturday morning in April I climbed out of my aging Honda Civic and stepped into the parking lot of the trading post in the Hopi village of Kykotsmovi. Across the pavement Hopi Cultural Preservation Office director Leigh Kuwanwisiwma motioned to me through the open window of his pickup truck. It was Leigh's sixty-fourth birthday and my partner and I were joining his family to plant early corn, as Leigh does each year. After a quick trip inside the trading post, we loaded into the back of Leigh's truck. Riding shotgun was Leigh's three-year-old grandson. The back seat was covered with vibrant blue kernels of corn that had fallen out of a bucket and scattered themselves across the worn leather seat. Carefully picking them up, we returned them to a bucket that also held whole ears of Hopi blue corn and settled in for the ride.

The truck came to a halt after a series of sandy, somewhat washed out roads leading to Leigh's field. We stepped out of the pickup and made our way to the sandy field where the corn we planted that day would take root. Near the field was an old tractor, purchased decades ago by Leigh's father. Like his father, Leigh used a tractor to prepare the field prior to his birthday. We spent the morning planting kernels of vibrant orange corn, and later celebrated at Leigh's house with food the women in his family prepared. When I returned to help Leigh harvest his fields of white and blue corn later that autumn, I asked him how the early corn had fared. He told me it sadly did not produce a crop, but was stunted in its growth due to climatic factors. This would not, however, discourage him from planting early corn the following spring. The story of Leigh's early cornfield that particular year is reflective of broader changes in Hopi agriculture, both historically and in the present. The old tractor that sits at the edge of the field speaks to Hopi adaptation and resilience as well as to economic change.

Over the course of the twentieth century, Hopi food and water systems underwent significant changes linked to broader ecological and socioeconomic changes both on and off the reservation. Beginning with on-reservation employment resulting from New Deal programs like the Civilian Conservation Corps – Indian Division, Hopis acted upon increasing wage labor opportunities. World War II served as a significant turning point for Hopi labor as men and women alike left home for jobs in war-related industries or to serve in the armed forces. At the same time, forced federal reduction of Hopi livestock during the 1940s made it impossible for many returning home at the war's end to find economic security through traditional livestock practices. This, in turn, contributed to the movement of Hopi laborers into regional and national labor markets. As Hopi labor traveled away from the fields and into the marketplace, farming on the reservation declined significantly. This was further complicated by the boarding school experience that left many families without the communal agricultural labor they once relied upon.

As fewer Hopis continued to farm, more and more pressure was placed upon those who tended their fields to produce the crops necessary for cultural and social events. Hopi farmers adapted their technology to enable the continuation of traditional subsistence practices despite labor challenges. The adoption of the tractor allowed farmers to accomplish work that required the labor of Hopi men while still working as wage laborers on the reservation, in border towns like Winslow and Flagstaff, and seasonally in far-flung places across the region from whence they would return to plant their fields.

A decline in agricultural production on the Hopi Indian Reservation and a spike in wage labor contributed to a shift away from traditional Hopi foods. The Hopi diet, once comprised primarily of plants and animals produced on the Hopi Mesas, was replaced with a Western diet.

Wages earned by Hopi labor and livestock sales enabled the purchase of food from local trading posts and regional grocery stores, and federal food aid programs like Food Stamps, the National School Lunch Program, and the Commodity Supplemental Food Program contributed to accessibility of Western foods for Hopis with limited cash resources. These changes gained increasing traction in the 1960s and by the end of the twentieth century most Hopis did not consume traditional foods as the primary component of their daily diets. Declines in agrobiodiversity and increasing rates of obesity and diabetes accompanied this dietary transformation, contributing to a public health crisis of epidemic proportions.

As Hopi food and labor system were undergoing significant changes, so too was water on the Hopi Indian Reservation. Between the 1930s and the end of the twentieth century, Hopi water resources were developed for a variety of uses including livestock, domestic consumption, and industrial development. These developments have put increasing pressure on Hopi water, contributing to declining water levels in regional aquifers. This is further complicated by long periods of drought experienced on the Hopi Indian Reservation, with deep drought conditions beginning in the late 1990s and continuing through the present.⁵²²

Hopi agriculturalists are astute observers of the local environment due in part to their dependence upon it for farming, gardening, and ranching. Both short- and long-term ecological observations shape their interactions with water, land, plants, and animals as they maintain one of North America's oldest agricultural systems. Hopi farmers, gardeners, and ranchers observed declines in multiple water resources across the Hopi Indian Reservation, most notably declines in the discharge of springs historically utilized for agricultural and domestic use and in windmills.

⁵²² Crimmins et al., "Hopi Climate: An Overview to Support Drought Monitoring and Management," 5.

These declines coincide with increased pumping of groundwater for domestic use and by Peabody Coal. Hopis also reported decreases in rainfall and associated surface water levels, particularly those surface water resources like earth dams used by Hopi ranchers to water their livestock. These changes in water resources are affecting the ability of many Hopis to continue traditional subsistence practices on the Hopi Indian Reservation. Many farmers, gardeners, and ranchers are choosing to discontinue – at least temporarily - agricultural practices due to a lack of water or shifting climate. The utilization of the local ecological knowledge these agriculturalists possess, including historical ecological knowledge, facilitates an understanding of how resource development and climate change are affecting agriculture on the Hopi Indian Reservation. Incorporating this knowledge into temporally expansive studies of food and water systems over time is critical to understanding and adapting to environmental change in an agricultural context.

The Hopi study is reflective of larger processes of environmental and economic transformation affecting rural communities around the world. While scientists examine the quantifiable ways in which climate change and the development of natural resources affect local environments, the ways in which these processes alter public health, traditional lifeways and the ability of indigenous peoples to continue practicing them in rapidly shifting environments remains under-explored. This study highlights the relationship between traditional subsistence practices, economic development, and ecological change demonstrating the utility of collating historical, scientific and local knowledge in an effort to gain a more comprehensive understanding of public and environmental health in the twenty-first century.

BIBLIOGRAPHY

Manuscript Collections

A.F. Whiting Collection, 1930-1979 (MS 25). Special Collections. Cline Library. Northern Arizona University. Flagstaff.

Alfred Whiting Collection, 1930-1981. Museum of Northern Arizona. Flagstaff.

Hopi Indian Agency Agricultural Extension Reports (MS 145). Special Collections. Cline Library. Northern Arizona University. Flagstaff.

Hopi Traditionalist Movement Papers, 1949-1972 (AZ 374). Special Collections. University of Arizona. Tucson.

Lyndon Baines Johnson Archives. Lyndon Baines Johnson Presidential Library. Austin, Texas.

Native Seeds/SEARCH Archives. Tucson.

Stewart L. Udall Papers (AZ 372). Special Collections. University of Arizona. Tucson.

U.S. Bureau of Indian Affairs Records (RG 75). National Archives. Washington, D.C.

Periodicals

Colorado Plateau Environmental Advisory Council Newsletter (Flagstaff.)

Hopi Action News (New Oraibi.)

Navajo Hopi Observer (Flagstaff.)

Quatoqti (New Oraibi.)

Tutuveni (Kykotsmovi.)

Winslow Mail (Winslow.)

Books, Articles, and Reports

Ali, Saleem H. *Mining, the Environment, and Indigenous Development Conflicts*. Tucson: University of Arizona Press, 2009.

Avakian, Arlene Voski, and Barbara Haber, eds. *From Betty Crocker to Feminist Food Studies: Critical Perspectives on Women and Food*. Amherst: University of Massachusetts Press, 2005.

- Beaglehole, Ernest, and Pearl Beaglehole. *Notes on Hopi Economic Life*, Yale University Publications in Anthropology 15. New Haven: Yale University Press, 1937.
- Beaglehole, Pearl, and Ernest Beaglehole. "Foods and Their Preparation." In *Notes on Hopi Economic Life*, 60–71. Yale University Publications in Anthropology 15. New Haven: Yale University Press, 1937.
- Belasco, Warren, and Philip Scranton, eds. *Food Nations: Selling Taste in Consumer Societies*. New York: Routledge, 2001.
- Benedek, Emily. *The Wind Won't Know Me: A History of the Navajo-Hopi Land Dispute*. New York: Knopf, 1992.
- Bentley, Amy. *Inventing Baby Food: Taste, Health, and the Industrialization of the American Diet*. Oakland, California: University of California Press, 2014.
- Bernstein, Alison R. *American Indians and World War II: Toward a New Era in Indian Affairs*. Norman: University of Oklahoma Press, 1991.
- Bertram, Kenneth M, and Gary M Kaszynski. "A Comparison of Coal-Water Slurry Pipeline Systems." *EGY Energy* 11, no. 11 (1986): 1167–80.
- Bicker, Alan, Paul Sillitoe, and Johan Pottier, eds. *Development and Local Knowledge: New Approaches to Issues in Natural Resources Management, Conservation and Agriculture*. London and New York: Routledge, 2004.
- Biltekoff, Charlotte. *Eating Right in America: The Cultural Politics of Food and Health*. Durham: Duke University Press Books, 2013.
- Blanchard, David O. "A Comparison of Wind Speed and Forest Damage Associated with Tornadoes in Northern Arizona." *Weather Forecasting* 28 (2013): 408–17.
- Bocking, Stephen. *Nature's Experts: Science, Politics, and the Environment*. New Brunswick, NJ: Rutgers University Press, 2004.
- Boyce, George A. *When Navajos Had Too Many Sheep: The 1940's*. San Francisco: The Indian Historian Press, 1974.
- Bradfield, Maitland. *The Changing Pattern of Hopi Agriculture*. London: Royal Anthropological Institute, 1971.
- Bravo, M.T. "Voices from the Sea Ice: The Reception of Climate Impact Narratives." *Journal of Historical Geography* 35, no. 2 (2009): 256–78.

- Brenton, Barrett P. "Hopi Foodways: Biocultural Perspectives on Change and Contradiction." Ph.D. Dissertation, University of Massachusetts Amherst, 1994.
- Brown, Amy C, and Barrett Brenton. "Dietary Survey of Hopi Native American Elementary Students." *Journal of the American Dietetic Association* 94, no. 5 (1994).
- Brown, James G., and James H. Eychaner. "Simulation of Five Ground-Water Withdrawal Projections for the Black Mesa Area, Navajo and Hopi Indian Reservations, Arizona." Tucson, Arizona: U.S. Geological Survey, Prepared in cooperation with the U.S. Office of Surface Mining Reclamation and Enforcement, February 1988.
- Brugge, David M. *The Navajo-Hopi Land Dispute: An American Tragedy*. Albuquerque: University of New Mexico Press, 1999.
- Brush, Stephen B. *Farmers' Bounty: Locating Crop Diversity in the Contemporary World*. New Haven: Yale University Press, 2004.
- Bunten, Alexis Celeste. "More like Ourselves: Indigenous Capitalism through Tourism." *The American Indian Quarterly* 34, no. 3 (2010): 285–311.
- Bureau of Reclamation, United States Department of the Interior. "Final Environmental Statement, Navajo Project," February 4, 1972.
- Butler, Caroline F., and Charles R. Menzies. "Working in the Woods: Tsimshian Resource Workers and the Forest Industry of British Columbia." *The American Indian Quarterly* 25, no. 3 (2001): 409–30.
- Calloway, D. H, R. D Giauque, and F. M Costa. "The Superior Mineral Content of Some American Indian Foods in Comparison to Federally Donated Counterpart Commodities." *Ecology of Food and Nutrition Ecology of Food and Nutrition* 3, no. 3 (1974): 203–11.
- Calloway, D. H, and J. C Gibbs. "Food Patterns and Food Assistance Programs in the Cocopah Indian Community." *Ecology of Food and Nutrition Ecology of Food and Nutrition* 5, no. 4 (1976): 183–96.
- Campbell, M.R., and Herbert H. Gregory. "The Black Mesa Coal Field." Paper. U.S. Geological Survey Bulletin. Washington, D.C.: GPO, 1911.
- Carolan, Michael S. *Embodied Food Politics*. Ashgate, 2012.
- Carter, George F. "Some Hopi Indian Food Herbs." *The Herbarist* 12 (1946): 32–36.
- Chamberlain, Kathleen P. *Under Sacred Ground: A History of Navajo Oil, 1922-1982*. Albuquerque: University of New Mexico Press, 2008.

- Chambers, Kimberlee. "From the Kitchen and the Field: Gender and Maize Diversity in the Bajío Region of Mexico." *Singapore Journal of Tropical Geography* 28, no. 1 (March 2007): 39–56.
- Chew, Matthew K. "The Monsterring of Tamarisk: How Scientists Made a Plant into a Problem." *Journal of the History of Biology* 42, no. 2 (2009): 231–66.
- Child, Brenda J. *My Grandfather's Knocking Sticks: Ojibwe Family Life and Labor on the Reservation*. St. Paul: Minnesota Historical Society Press, 2014.
- Clemmer, Richard. *Roads in the Sky: The Hopi Indians in a Century of Change*. Boulder: Westview Press, 1995.
- Clemmer, Richard O. "Black Mesa and the Hopi." In *Native Americans and Energy Development*, by Joseph G. Jorgensen, Richard O. Clemmer, Ronald L. Little, Nancy J. Owens, and Lynn A. Robbins, 17–34. Cambridge, Massachusetts: Anthropology Resource Center, 1978.
- Collette, Liana K. D, and Jason Pither. "Russian-Olive (*Elaeagnus Angustifolia*) Biology and Ecology and Its Potential to Invade Northern North American Riparian Ecosystems." *Invasive Plant Science and Management* 8, no. 1 (2015): 1–14.
- Collins, G.N. "A Drought-Resisting Adaptation in Seedlings of Hopi Maize." *Journal of Agricultural Research* 1, no. 4 (January 10, 1914): 293–302.
- Colombi, Benedict J. "Dammed in Region Six: The Nez Perce Tribe, Agricultural Development, and the Inequality of Scale." *American Indian Quarterly* 29, no. 3/4 (July 2005): 560–89.
- Congressional Quarterly. "Development to Be Pushed on Indian Reservations." *Congressional Quarterly*, July 24, 1961.
- Cooley, M. E., J.W. Harshbarger, J. P. Akers, and W.F. Hardt. "Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a Section on Vegetation." Washington, D.C.: U.S. Geological Survey, Prepared in cooperation with the Bureau of Indian Affairs and the Navajo Tribe, 1969.
- Cooley, M. E., J.W. Harshbarger, J. P. Akers, W.F. Hardt, and O.N. Hicks. "Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, with a Section on Vegetation." Tucson, Arizona: U.S. Geological Survey, December 1964.
- Crimmins, Michael A., Daniel B. Ferguson, Jeremy L. Weiss, and Holly Faulstich. "Hopi Climate: An Overview to Support Drought Monitoring and Management." Tucson: University of Arizona, 2015.

- Cronon, William. *Nature's Metropolis: Chicago and the Great West*. New York: W.W. Norton, 1991.
- Cunfer, Geoff. *On the Great Plains: Agriculture and Environment*. College Station: Texas A&M University Press, 2005.
- Daniel, Pete. *Breaking the Land : The Transformation of Cotton, Tobacco, and Rice Cultures since 1880*. Urbana: University of Illinois Press, 1985.
- DeJong, David H. *Stealing the Gila: The Pima Agricultural Economy and Water Deprivation, 1848-1921*. Tucson: University of Arizona Press, 2009.
- Deutsch, Tracey. *Building a Housewife's Paradise: Gender, Politics, and American Grocery Stores in the Twentieth Century*. Chapel Hill: The University of North Carolina Press, 2012.
- Dobyns, Henry F. "Blunders with Bolsas: A Case Study of Diffusion of Closed-Basin Agriculture." *Human Organization*, Fall 1951, 25–32.
- . *Papagos in the Cotton Fields*. Tucson, Arizona: University of Arizona, Department of Anthropology, 1951.
- Eggan, Frederick Russell, and Michel Pijoan. "Some Problems in the Study of Food and Nutrition." *America Indigena* 3, no. 1 (January 1943): 9–22.
- Ferreira, Mariana K. Leal, and Gretchen Chesley Lang, eds. *Indigenous Peoples and Diabetes: Community Empowerment and Wellness*. Durham, N.C: Carolina Academic Press, 2006.
- Fewkes, J. Walter. "A Contribution to Ethnobotany." *American Anthropologist* 9, no. 1 (January 1896): 14–21.
- Fiege, Mark. *Irrigated Eden: The Making of an Agricultural Landscape in the American West*. Seattle: University of Washington Press, 1999.
- Fischer, Frank. *Citizens, Experts, and the Environment: The Politics of Local Knowledge*. Durham and London: Duke University Press, 2000.
- Fitzgerald, Deborah Kay. *Every Farm a Factory: The Industrial Ideal in American Agriculture*. New Haven: Yale University Press, 2003.
- Fixico, Donald Lee. *The Invasion of Indian Country in the Twentieth Century: American Capitalism and Tribal Natural Resources*. Boulder: University Press of Colorado, 2012.

- Flora, Cornelia Butler Livingston, Matt, Honyestewa, Iva, Koiyaquaptewa, Harrissa. "Understanding Access to and Use of Traditional Foods by Hopi Women." *Journal of Hunger & Environmental Nutrition* 4, no. 2 (2009): 158–71.
- Forde, C. "Hopi Agriculture and Land Ownership." *Journal of the Anthropological Institute of Great Britain and Ireland* 61 (1931): 357.
- Gregg, Sara. "Uncovering the Subsistence Economy in the Twentieth-Century South: Blue Ridge Mountain Farms." *Agricultural History* 78, no. 4 (October 2004): 417–37.
- Gregory, Herbert E. "The Navajo Country--a Geographic and Hydrographic Reconnaissance of Parts of Arizona, New Mexico and Utah." United States Geological Survey, 1916.
- Hack, John Tilton. *The Changing Physical Environment of the Hopi Indians of Arizona*. Reports of the Awatovi Expedition, Peabody Museum, Harvard University. Report No. 1. Cambridge, Mass: The Museum, 1942.
- Hall, Edward T. *West of the Thirties: Discoveries among the Navajo and Hopi*. New York: Doubleday, 1994.
- Halpenny, Leonard Cameron, and John William Harshbarger. "Preliminary Report on the Ground-Water Resources of the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah." Holbrook, Arizona: United States Geological Survey, August 1951.
- Hamilton, Shane. "Cold Capitalism: The Political Ecology of Frozen Concentrated Orange Juice." *Agricultural History* 77, no. 4 (October 2003): 557–81.
- Harmon, Alexandra. *Indians in the Making: Ethnic Relations and Indian Identities Around Puget Sound*. Berkeley and Los Angeles: University of California Press, 1998.
- Helms, Douglas, United States, Soil Conservation Service, and Economics and Social Sciences Division. *Readings in the History of the Soil Conservation Service*. Washington, D.C.: U.S. Dept. of Agriculture, Soil Conservation Service, Economics and Social Sciences Division, NHQ, 1992.
- Higgins, Daniel. *The Black Mesa Case Study: A Postaudit and Pathology of Coal-Energy Groundwater Exploitation in the Hopi and Dine Lands, 1968-2008*. Tucson: University of Arizona, 2010.
- Hill, George W. "Progress Report on Black Mesa Monitoring Program-1984." Tucson, Arizona: U.S. Geological Survey, Prepared in cooperation with the Arizona Department of Water Resources and the U.S. Bureau of Indian Affairs, August 1985.
- Hirt, Paul W. *The Wired Northwest: The History of Electric Power, 1870s-1970s*. Lawrence: University Press of Kansas, 2012.

- Holm, Tom. "Fighting a White Man's War: The Extent and Legacy of Indian Participation in World War II." In *The Plains Indians of the Twentieth Century*, edited by Peter Iverson. Norman: University of Oklahoma Press, 1986.
- Hosmer, Brian. "'Dollar a Day and Glad to Have It': Work Relief on the Wind Indian Reservation as Memory." In *Native Pathways: American Indian Culture and Economic Development in the Twentieth Century*, edited by Brian Hosmer, Colleen O'Neill, and Donald L. Fixico, 283–307. Boulder: University Press of Colorado, 2004.
- Hosmer, Brian C. *American Indians in the Marketplace: Persistence and Innovation among the Menominees and Metlakatans, 1870-1920*. Development of Western Resources. Lawrence: University Press of Kansas, 1999.
- Hough, Walter. "Environmental Interrelations in Arizona." *American Anthropologist* 11, no. 5 (May 1898): 133–55.
- . "The Hopi in Relation to Their Plant Environment." *American Anthropologist* 10, no. 2 (February 1897): 33–44.
- Ingram, Robert S. *Arizona "Eddy" Tornadoes*. NOAA Technical Memorandum; NWSTM WR-91. Salt Lake City, Utah: U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Western Region, 1973.
- Iverson, Peter. *The Plains Indians of the Twentieth Century*. Norman: University of Oklahoma Press, 1986.
- . *When Indians Became Cowboys: Native Peoples and Cattle Ranching in the American West*. Norman: University of Oklahoma Press, 1994.
- Jacobs, B. E. A. *Design of Slurry Transport Systems*. New York: Taylor & Francis, 1991.
- Justice, James W. "Twenty Years of Diabetes on the Warm Springs Indian Reservation, Oregon." *American Indian Culture and Research Journal* 13, no. 3 (1989): 49–81.
- Karr, Steven M. "'Water We Believed Could Never Belong to Anyone': The San Luis Rey River and the Pala Indians of Southern California." *American Indian Quarterly* 24, no. 3 (July 2000): 381–99.
- Katz, Gabrielle L, and Patrick B Shafroth. "Biology, Ecology and Management of *Elaeagnus Angustifolia* L. (Russian Olive) in Western North America." *Wetlands* 23, no. 4 (2003): 763–77.
- Kelly, William H. *Indians of the Southwest: A Survey of Indian Tribes and Indian Administration in Arizona*. Annual Report - Bureau of Ethnic Research, University of Arizona, Tucson: University of Arizona, 1953.

- Kennard, Edward. "Hopi Economy and Subsistence." In *Handbook of North American Indians*, edited by Alfonso Ortiz, 9:554–63. Washington, D.C.: U.S. Government Printing Office, 1979.
- Kennard, Edward A. "Post-War Economic Changes among the Hopi." In *Essays in Economic Anthropology: Proceedings of the 1965 Annual Spring Meeting of the American Ethnological Society*, edited by June Helm and Karl Polanyi, 24–32. Seattle: University of Washington Press, 1965.
- Kerr, Norwood Allen. "Drafted into the War on Poverty: USDA Food and Nutrition Programs, 1961-1969." *Agricultural History* 64, no. 2 (Spring 1990): 154–66.
- King, Janet C. "Doris Howes Calloway (1923–2001)." *The Journal of Nutrition* 133, no. 7 (July 2003): 2113–16.
- Koeppel, Dan. *Banana: The Fate of the Fruit That Changed the World*. New York: Hudson Street Press, 2008.
- Kopp, Judy. "Crosscultural Contacts: Changes in the Diet and Nutrition of the Navajo Indians." *American Indian Culture and Research Journal* 10, no. 4 (January 1986): 1–30.
- Kuhnlein, H. V., Calloway D.H. "Contemporary Hopi Food Intake Patterns." *Ecology of Food and Nutrition* 6, no. 3 (1977): 159–73.
- Kurlansky, Mark. *Cod: A Biography of the Fish That Changed the World*. New York: Walker and Co., 1997.
- . *Salt: A World History*. New York: Walker and Co., 2002.
- LaDuke, Winona. *Recovering the Sacred: The Power of Naming and Claiming*. Cambridge, MA: South End Press, 2005.
- Levine, Susan. *School Lunch Politics: The Surprising History of America's Favorite Welfare Program*. Princeton: Princeton University Press, 2010.
- Lewis, David Rich. *Neither Wolf Nor Dog: American Indians, Environment, and Agrarian Change*. New York: Oxford University Press, 1997.
- Littlefield, Alice, and Martha C. Knack, eds. *Native Americans and Wage Labor: Ethnohistorical Perspectives*. Norman: University of Oklahoma Press, 1996.
- Massey, Garth M. "Making Sense of Work on the Wind River Indian Reservation." *American Indian Quarterly* 28, no. 3/4 (July 2004): 786–816.
- McGregor, Deborah. "Coming Full Circle: Indigenous Knowledge, Environment, and Our Future." *American Indian Quarterly* 28, no. 3/4 (July 2004): 385–410.

- Meeks, Eric V. "The Tohono O'odham, Wage Labor, and Resistant Adaptation, 1900-1930." *The Western Historical Quarterly* 34, no. 4 (December 1, 2003): 468–89.
- Mintz, Sidney. *Sweetness and Power: The Place of Sugar in Modern History*. New York: Viking, 1985.
- Montgomery, Edward, and John W. Bennett. "Anthropological Studies of Food and Nutrition: The 1940s and the 1970s." In *The Uses of Anthropology*. Washington: American Anthropological Association, 1979.
- Mudry, Jessica J. *Measured Meals: Nutrition in America*. Albany: State University of New York Press, 2010.
- Nabhan, Gary Paul. *Enduring Seeds: Native American Agriculture and Wild Plant Conservation*. Tucson: University of Arizona Press, 2002.
- . *Where Our Food Comes From: Retracing Nikolay Vavilov's Quest to End Famine*. Washington, DC: Island Press, 2011.
- . *Why Some Like It Hot: Food, Genes, and Cultural Diversity*. Washington, D.C.: Island Press, 2006.
- National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases (U.S.), and National Diabetes Data Group (U.S.), eds. *Diabetes in America*. NIH Publication, no. 95-1468. Bethesda, Md.: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 1995.
- Natwani Coalition. "Current State of Hopi Food and Farming," 2005.
- Nazarea, Virginia D. *Heirloom Seeds and Their Keepers: Marginality and Memory in the Conservation of Biological Diversity*. Tucson: University of Arizona Press, 2005.
- Needham, Andrew. *Power Lines: Phoenix and the Making of the Modern Southwest*, 2014.
- Nequatewa, Edmund, Alfred F Whiting, and P. David Seaman. *Born a Chief: The Nineteenth Century Hopi Boyhood of Edmund Nequatewa, as Told to Alfred F. Whiting*. Tucson: University of Arizona Press, 1993.
- Nestle, Marion. *Food Politics: How the Food Industry Influences Nutrition and Health*. Berkeley: University of California Press, 2013.
- Norrgard, Chantal. "From Berries to Orchards: Tracing the History of Berrying and Economic Transformation among Lake Superior Ojibwe." *American Indian Quarterly* 33, no. 1 (January 2009): 33–61.

- Norton, Jay B, Roman R Pawluk, and Jonathan A Sandor. "Observation and Experience Linking Science and Indigenous Knowledge at Zuni, New Mexico." *Journal of Arid Environments* 39, no. 2 (1998): 331–40.
- Oliveira, Victor J, United States, Department of Agriculture, and Economic Research Service. *The WIC Program: Background, Trends, and Issues*. Washington, DC: U.S. Dept. of Agriculture, Economic Research Service, 2002.
- O'Neill, Colleen. *Working the Navajo Way: Labor and Culture in the Twentieth Century*. Lawrence: University Press of Kansas, 2005.
- Parman, Donald L. *The Navajos and the New Deal*. New Haven: Yale University Press, 1976.
- Parman, Donald Lee. "The Indian Civilian Conservation Corps." Ph.D., The University of Oklahoma, 1967.
- Pearson, Byron E. "'We Have Almost Forgotten How to Hope': The Hualapai, the Navajo, and the Fight for the Central Arizona Project, 1944-1968." *The Western Historical Quarterly* 31, no. 3 (October 1, 2000): 297–316.
- Petrick, Gabriella M. "The Arbiters of Taste: Producers, Consumers and the Industrialization of Taste in America, 1900-1960." University of Delaware, 2006.
- Reisner, Marc. *Cadillac Desert: The American West and Its Disappearing Water*. New York: Viking, 1986.
- Rosier, Paul C. "Searching for Salvation and Sovereignty: Blackfoot Oil Leasing and the Reconstruction of the Tribe." In *Native Pathways: American Indian Culture and Economic Development in the Twentieth Century*, edited by Brian C. Hosmer, Colleen O'Neill, and Donald L. Fixico, 27–51. Boulder: University Press of Colorado, 2004.
- Rushforth, Scott, and Steadman Upham. *A Hopi Social History: Anthropological Perspectives on Sociocultural Persistence and Change*. Austin: University of Texas Press, 1992.
- Sackman, Douglas. *Orange Empire: California and the Fruits of Eden*. Berkeley and Los Angeles: University of California Press, 2005.
- Sakiestewa Gilbert, Matthew. *Education beyond the Mesas: Hopi Students at Sherman Institute, 1902-1929*. Lincoln: University of Nebraska Press, 2010.
- Satterfield, Dawn, Lemyra DeBruyn, Carolee Dodge Francis, and Aiko Allen. "A Stream Is Always Giving Life: Communities Reclaim Native Science and Traditional Ways to Prevent Diabetes and Promote Health." *American Indian Culture and Research Journal* 38, no. 1 (2014): 157–90.

- Sekaquaptewa, Helen, and Louise Udall. *Me and Mine: The Life Story of Helen Sekaquaptewa*. Tucson: University of Arizona Press, 1969.
- Sher, Anna, and Martin F Quigley. *Tamarix: A Case Study of Ecological Change in the American West*. New York, NY: Oxford University Press, 2013.
- Sheridan, Thomas. *Arizona: A History*. Tucson: University of Arizona Press, 1995.
- Shoemaker, Craig, Jeffrey T Davis, United States, National Weather Service, Western Region, and Scientific Services Division. *Hazardous Weather Climatology for Arizona*. Salt Lake City, UT: U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Scientific Services Division, Western Region, 2008.
- Sillitoe, Paul, and Julian Barr. "A Decision Model for the Incorporation of Indigenous Knowledge into Development Projects." In *Investigating Local Knowledge: New Directions, New Approaches*, edited by Alan Bicker, Paul Sillitoe, and Johan Pottier, 59–88. Burlington: Ashgate, 2004.
- Simmons, Kevin M., and Daniel Sutter. *Economic and Societal Impacts of Tornadoes*. Boston: American Meteorological Society, 2011.
- Smith-Morris, Carolyn. *Diabetes among the Pima: Stories of Survival*. Tucson: University of Arizona Press, 2008.
- Soleri, Daniela, and David A. Cleveland. "Hopi Crop Diversity and Change." *Journal of Ethnobiology* 13, no. 2 (Winter 1993): 203–31.
- Soluri, John. "Accounting for Taste: Export Bananas, Mass Markets, and Panama Disease." *Environmental History* 7, no. 3 (2002): 386–410.
- Steen-Adams, Michelle, Nancy Langston, and David Mladenoff. "Logging the Great Lakes Indian Reservations: The Case of the Bad River Band of Ojibwe." *American Indian Culture and Research Journal* 34, no. 1 (January 2010): 41–66.
- Steinberg, Theodore. *Acts of God: The Unnatural History of Natural Disaster in America*. New York: Oxford University Press, 2000.
- Stewart, Guy R. "Conservation in Pueblo Agriculture: II. Present-Day Flood Water Irrigation." *The Scientific Monthly* 51, no. 4 (October 1940): 329–40.
- Suryanarayanan S, and Kleinman D.L. "Be(e)coming Experts: The Controversy over Insecticides in the Honey Bee Colony Collapse Disorder." *Social Studies of Science* 43, no. 2 (2013): 215–40.

- Thrush, Coll, and Ruth S. Ludwin. "Finding Fault: Indigenous Seismology, Colonial Science, and the Rediscovery of Earthquakes and Tsunamis in Cascadia." *American Indian Culture and Research Journal* 31, no. 4 (January 2007): 1–24.
- Titiev, Mischa. *Old Oraibi: A Study of the Hopi Indians of Third Mesa*. Peabody Museum of Archaeology and Ethnology Papers v.22,no.1. Cambridge, Mass: Published by the Museum, 1944.
- . *The Hopi Indians of Old Oraibi: Change and Continuity*. Ann Arbor: University of Michigan Press, 1972.
- United States. *Hopi Hearings, July 15-30, 1955*. Keams Canyon, Ariz: The Bureau, 1955.
- . *Survey of Conditions of the Indians in the United States: Hearings before a Subcommittee of the Committee on Indian Affairs, United States Senate, Seventy-First Congress, Part 18*. Washington: United States Government Printing Office, 1932.
- Vasquez, Miguel. "The Hopi of Northern Arizona." In *Endangered Peoples of North America: Struggles to Survive and Thrive*, edited by Tom Greaves. Westport: Greenwood Press, 2001.
- Veit, Helen Zoe. *Modern Food, Moral Food: Self-Control, Science, and the Rise of Modern American Eating in the Early Twentieth Century*. Chapel Hill: The University of North Carolina Press, 2013.
- Wall, Dennis, and Virgil Masayesva. "People of the Corn: Teachings in Hopi Traditional Agriculture, Spirituality, and Sustainability." *American Indian Quarterly* 28, no. 3/4 (July 2004): 435–53.
- Watson, James B. "The Historical Development of Hopi Economy and Its Relations to Other Aspects of Culture." M.A., The University of Chicago, 1945.
- Weisiger, Marsha. *Dreaming of Sheep in Navajo Country*. Seattle: University of Washington Press, 2009.
- Whiteley, Peter M. *Rethinking Hopi Ethnography*. Smithsonian Series in Ethnographic Inquiry. Washington, D.C.: Smithsonian Institution Press, 1998.
- Whiteley, Peter, and Vernon Masayesva. "The Use and Abuse of Aquifers: Can the Hopi Indians Survive Multinational Mining?" In *Water, Culture, and Power: Local Struggles in a Global Context*, edited by John Donahue, 9–34. Washington, D.C.: Island Press, 1998.
- White, Richard. *The Organic Machine*. New York: Hill and Wang, 1995.
- . *The Roots of Dependency: Subsistence, Environment, and Social Change among the Choctaws, Pawnees, and Navajos*. Lincoln: University of Nebraska Press, 1988.

- Whiting, Alfred F. *Ethnobotany of the Hopi*. Flagstaff: Northern Arizona Society of Science and Art, 1939.
- Wilkinson, Charles F. *Fire on the Plateau: Conflict And Endurance In The American Southwest*. Washington, D.C.: Island Press, 1999.
- Williams-Forsion, Psyche A. *Building Houses out of Chicken Legs: Black Women, Food, and Power*. Chapel Hill: The University of North Carolina Press, 2006.
- Wilson, Angela Cavender. "Introduction: Indigenous Knowledge Recovery Is Indigenous Empowerment." *The American Indian Quarterly* 28, no. 3 (2004): 359–72.
- Wilson, Virginia. "How Many Sheep Are Too Many? : A Documentary Study of the Sociocultural Impact of the Livestock Reduction Program on the Hopi," 1993.
- Worster, Donald. *Dust Bowl: The Southern Plains in the 1930s*. New York: Oxford University Press, 1979.
- . *Rivers of Empire: Water, Aridity, and the Growth of the American West*. Reprint edition. Oxford, England; New York: Oxford University Press, 1992.