UC Berkeley
UC Berkeley Electronic Theses and Dissertations

Title

Internalizing Fire: At What Cost and Scale? An Economic Geography of Fire Across California and North American Landscapes, the Mobility of Labor Over Land, and the Politics of Practice

Permalink

https://escholarship.org/uc/item/3534d5x4

Author

Best, Dennis Vahid

Publication Date

2024

Peer reviewed|Thesis/dissertation

eScholarship.org Powered by the California Digital Library
University of California

Internalizing Fire: At What Cost and Scale?

An Economic Geography of Fire Across California and North American Landscapes, the Mobility of Labor Over Land, and a Politics of Practice

By

Dennis Vahid Best

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Energy and Resources

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Christopher Ansell, Co-Chair
Professor Scott Stephens, Co-Chair
Professor Hidetaka Hirota
Professor Isha Ray

Summer 2024

Abstract

Internalizing Fire: At What Cost and Scale?
An Economic Geography of Fire Across California and North American Landscapes, the Mobility of Labor Over Land, and a Politics of Practice

by

Dennis Vahid Best

Doctor of Philosophy in Energy and Resources

University of California, Berkeley

Professors Christopher Ansell, Co-Chair and Scott Stephens, Co-Chair

This dissertation develops interdisciplinary methods to illuminate the challenges at the intersection of fire ecology and decision in complex adaptive systems. Contemporary dialogues at the intersection of fire, energy and land use require novel understanding of these interactions to better address complex systems interacting across global and local ecological economic dimensions. The author builds from history and direct experience across institutions to develop an economic geographic analysis in theoretical and practical frames to advance the ecological choices and decisions that affect global climate change and adaptive governance in the face of fire, or rather “internalizing fire.” The practice of internalizing fire engages the transformation of external fire over the landscape through acts of suppression, displacement and exclusion and the rise of an internal fire through industrial and transport processes. As fire moves across the landscape, geographic information informs when fire is in effect present and absent. The term “internalized fire” is also used to investigate decision spaces, how institutions and individual actors may respond to internalizing these values in future stewardship and adaptive governance. The first chapter investigates an economic geography and historiography of “Bracero Burning” with primary archived data to examine the early motivation and administration of the Bracero program and the effect of this mid-twentieth century migrant labor policy on the rise of catastrophic fire, changing fire ecology across North American landscapes. The second chapter examines interactions between institutions, people and mobility across landscapes through a “Politics of Practice”.This adaptive capacity framework estimates costs and the scale of “labor over land,” in systems living with fire. These models provide theory and application for localized decision. Chapter three explores this economic geography in theory and practice with the restoration of Arctostaphylos Pungens, the “Mexican” Manzanita, a fire dependent species ranging across the study area, inhabited by participants and descendants of World War II era Braceros. A discussion of the plant’s significance provides socioeconomic perspective on costs and questions of internalizing fire across its habitat. The “Politics of Practice” offers concluding theory for a better balance in California’s fire ecology and adaptive decision, amid local and global dilemmas with proposed increase in frequency of localized and regional decision.

Dedication:

To the mobile work-force and coerced, whose migrations of labor over land have created wealth at a great scale and largely at a great cost to themselves and to local decisions on the land. May they arrive at home.

Figure 1: A cool evening for a hot clean burn? Images of 2018 prescribed fire scene; data on historic population distribution and fire ignitions in California

Acknowledgements:

I would like to thank the myriad of people and institutions that have made this dissertation and work possible. First I would like to acknowledge the State of California, my place of birth and home for affording me the space and time to develop this work from the very beginnings of my public education to my undergraduate university degree acquired in Political Science, International Relations, with a concentration in East Asian Studies at the University of California, Los Angeles (UCLA). In particular I would like to thank the late Professor Richard Baum for inspiring me to be a storyteller, like he was, and to his colleagues, Professors Cindy Fan and John Agnew in the (UCLA) Geography department that taught me early on how to think about migrations and arguing with regions. I would also like to acknowledge the tremendous role that the University of California has played in my academic journey and the opportunity to advance my interdisciplinary academic training with my Master of Science degree in Energy and Resources completed at the University of California Berkeley in 2017 that led to early formulation of my work on spatial dimensions of fire and theories of risk and regulation that I have included, in part, in this dissertation.

In particular, I would like to thank my committee members and primarily Professor Christopher Ansell for providing me useful feedback throughout, Professor Scott Stephens for guiding me in the field and in the learning of fire ecology. The Energy and Resources Group provided a unique learning environment to explore and investigate the questions that developed in my earlier career while working at the International Energy Agency(IEA)/Organization for Economic Cooperation and Development (OECD) on understanding patterns of global systems, biomass combustion and tradeoffs in Global and local energy systems. The guidance and discussions I shared with Prof. Richard Norgard, Prof. Isha Ray and Prof. Nathan Sayre enabled me to better understand institutional dynamics in approaching my questions from the social sciences and early conversations with Prof. John Harte, the late Prof. Peter Berke, Prof. Todd Dawson and Prof. Lara Kueppers were also important in developing perspectives related to an ecological framing of dynamic systems. Prof. Hidetaka Hirota helped me situate my work into the context of North America’s immigration histories, coerced labor, displacement and exclusionary policies.

My projects were made possible by funders in California including the California Energy Commission, California State Parks and the Sonoma Wildlife Collaborative, the Office of Research and Planning of the Governor of California, The National Science Foundation’s SUPERB Mentors program, in which I participated in as a mentor, the National Science Foundation’s Innovations at the Nexus of Food, Energy and Water Systems (INFEWS) program which provided a network of dialogues including with the engagement of indigenous voices in STEM fields. The University of California also provided me with fellowships including the Graduate Opportunity Fellowship and the Research Mentors fellowship along with departmental discretionary funds provided by the Energy and Resources Group later in my graduate work. The Chateaubriand Fellowship award I received from the French Embassy in the United States provided a unique opportunity to develop and learn in collaboration with colleagues at the University of Toulouse, Paul Sabatier, and colleagues at the Institute National Research Agronomique et Environment (INRAE) during research trips in 2018, 2019, and 2023. In particular, I would like to thank Stephane Couture, Marie Josie, Mathias and Patrick Taillander for including me in presenting my ideas and participating in workshops and exploring new perspectives in decision and modeling risk in economic and ecological systems. I would also like to acknowledge my collaborators and colleagues in Mexico that early on provided important perspectives on forest management across borders including Prof. Enrique Jardel, University of Guadalajara-Autlan, Prof. Diego Salicrup and Prof. Omar Masera at the University Nacional de Mexico (UNAM) at the Instituto Investigaciones Ecológicas (IIE). In addition I would like to thank Professor Stephen Pyne of Arizona State University for inviting me into his home on multiple occasions to share perspectives on institutions of fire and learn more from his works of art. On multiple occasions Pete Fule from Northern Arizona University provided a sounding board for fire questions across borders and provided a brief rest stop in Flagstaff en route across the Southwest. Prof. John Helms at UC Berkeley also provided some early inspiration in understanding forestry practice and advanced silviculture. The Special Collections staff at Bancroft Library at UC Berkeley, UC Davis and Stanford also facilitated my primary research at the archives in those locations.

Special thanks goes to my colleagues in the fire and forestry field that offered the chance to observe, monitor, prepare for and learn the practice of burning on landscapes in California that included activities at University of California Research Stations, State Parks, ecological preserves including the Audubon Canyon Ranch and privately held properties in Sonoma, Marin and El Dorado and Amador Counties. In particular, I would like to thank Rob York, Brandon Collins, Ariel, Susie Kocher, Kestrel, Chris, Sasha Berleman, Peter Nelson, and colleagues at California Conservation and Natural Resource Agency (CNRA), UCANR, the Nature Conservancy for experience gained through prescribed burn associations, institutional dialogues, Fire Forward hosted CAL TREX training and my wildland firefighter II certification through the Nature Conservancy. My routine participation in the Stephens Fire Ecology lab meetings also opened my eyes to new complexities in the field. My early work in energy systems also benefited from dialogues with colleagues in the mentorship of undergraduate and graduate students affiliated with the Renewable and Appropriate Energy Laboratory and Range Laboratory at UC Berkeley, which I participated in until 2020. The global community involved in developing open source data data and tools including the QGIS platform and iNaturalist citizen science data have been fundamental to my ability to work across technology boundaries and barriers. Thank you.

The Center for Latin American and Caribbean Studies (CLACS) provided me with dissertation writing space as a graduate affiliate in 2022 and provided an avenue to continue to explore the ancestral languages of my family which includes mestizo and indigenous cultures from Jalisco and Chihuahua Mexico. As part of the Uto-Aztecan language families the courses through partnership with the University of Utah provided an inspiring reconnection to the past and remote friendships during the pandemic. I would like to thank Prof. Abelardo De La Cruz, Julia Byrd and Gregory Loudon for their support, office space and a place to convene dialogues on fire during my two years of Nahuatl language instruction and related activities. The American Indian Graduate Program at UC Berkeley also provided substantial assistance when needed and much gratitude to Patrick Naranjo for hearing me and acknowledging my work in recent years. The non-financial support provided by these folks including the tremendous assistance of the Energy Resources Group Graduate Advisor Candace Gronkuetz were essential during some challenging times.

A special thanks to the American Association of Geographers (AAG) which truly brings together a wonderful event and a network of interdisciplinary thinking that provided me an opportunity to showcase early work that informed my final dissertation and perhaps my final destination. To Dustin O'brien and the tradesman at O'brien House Painting and Peter Hale of Hale's Hardwood who afforded me friendship and something to do when my vision was impaired for several months in 2021 and 2022, demonstrating that "Disability" can lead to new knowledge.

Finally, I would like to acknowledge the enormous support and contribution of my family including my mother Rosario Best, mi tia Madolyn Landers, Emily Best, Noah Best and Mia Best, who supported me with love, joy and laughter and a raison d'etre over the years. With more gratitude for the friends, plants, "gardeners" and Manzanitas I met along the way.

In life as in landscapes, things change, nature does not rush and yet everything is accomplished. I acknowledge that my birthplace, my field work and intellectual achievements would not have been possible without contributions from my ancestors, the energies embodied in life and the living, and the spaces that store the diverse indigenous, traditional and local ecological knowledges that have sustained us in our homes and provided food for our labor. May we honor those contributions with a more creative, and dare I say more playful, diplomatic, inclusive, more steady and sustained stewardship, whether that may be local or global in its directionality.

Table of Contents:

List of Figures

Chapter 2

Chapter 3

Conclusion

Introduction: Internalizing Fire: At what cost and scale?

This doctoral dissertation develops an interdisciplinary analysis using a unique mix of methods in practice that illuminate the challenges at the intersection of fire and decision in complex adaptive systems. The contemporary dialogues at the intersection of fire, energy and land use requires novel understanding of these interactions that can better simplify the complex systems that interact at the global and local ecological and economic dimensions. This work addresses this problem building from the author's own history, perspectives and experience across multileveled institutions to develop both practical and theoretical framings to advance thinking of the ecological choices and decisions that affect our global climate change and adaptive governance in practice.

In this dissertation the idea of internalizing fire is used both literally to discuss the transformation of external fire over the landscape through acts of suppression, displacement and exclusion and the rise of an internal fire through industrial and transport processes. The idea here is to identify the characteristics of fire on the landscape today and discuss the modes in which this fire is in effect present and absent. The term is also used metaphorically to discuss ways that we have not cognitively “internalized fire” in our decision space or mental models and how institutions and individual actors may respond from this externalized cost to internalizing these values in future stewardship and adaptive governance. These ideas are integrated throughout this work based on three distinct chapters representing mixed methodologies and concluded in a final discussion of the “Politics of Practice”.

This work begins in the first chapter with an investigation of the economic geography and historiography of “Bracero Burning” by engaging primary archived institutional data to examine the early motivation and administration of the Bracero program, how this mid twentieth century migrant labor policy further exacerbated the rise of catastrophic fire at both a local and global level and how this policy affected the Fire Ecology across North America’s landscapes culminating in the events we witness today.

This investigation in chapter one broadly relies on qualitative methods based on an analysis of information available through the open sourced data and tools, The Online Archive of California and related archived primary sourced materials in special collections housed in California. This includes review of select online Smithsonian Institutes archives and other oral narratives, selected from over over 3000 personal accounts of the Bracero’s experience and additional supporting information. Further, interviews with researchers and academics and practitioners engaged in forest and fire management in Mexico and in California were also conducted, along with site visits and engagement in local and federal certifications and practice for prescribed fire and other ethnographic work in the use of fire for indigenous and ecological management across public, private and ecological field research sites. These methods are further supplemented by review of the literature on migration labor, indigenous management practices and other scientific studies of fire ecological effects and use of fire across landscapes in North America.

Chapter one and chapter two engage the myth of California's unlimited resource and abundance of land up for grab which predates the gold rush and has its origin in the periods of Imperial conquest and colonization of indigenous people throughout the Americas (Vallejo Papers, Bancroft Library). Whether we believe the imperial past began with early Europeans landing in the Western hemisphere from the 1400s or consider the interaction of polities across North America and empires of Meso-America and Latin America that waxed and waned amid periods of conquest and contest among states (Graeber and Wengrow, 2021; Resendez, 2016) that led to continual migration, transported and forced labor, these changes resulted in shifts of resource intensity and land use which continue in California to the present day, predominantly in an urbanization and technocratic central planning framework (Howitt and Lunkapis, 2010).

Catastrophic wildfire events across North America, and in particular events in California have compounded the complex challenges of addressing climate change and the coupled human ecology of landscape management. This has important implications for resource management that include forest and fire policy in the Western United States and beyond (Stephens and Ruth, 2005). In addition, the effects have led to expansion of risks posed by fire to the network of energy, transport and built human environment in an expanded fire season (Westerling et al, 2008). As the time scale, and frequency of fires has been augmented significantly in the 20th century, it is important to examine the complex interactions and fire histories including knowledge gaps in indigenous stewardship (Stephens et al. 2023) that have led to the current state of affairs and a shifting ecological frame that is linked to historic land use, management and contemporary labor decisions and practices. Over time, these long human and ecological coupled practices were then decoupled from cycles of traditional burning and localized approaches that met the resource needs and stewardship objectives of local peoples and neighboring communities (Anderson, 2005; Stewart, 2002; Biswell, 1999). Omer Stewart and contemporary fire ecologists provide evidence that the records of indigenous people's setting fires throughout North America make it apparent that this activity was an important ecological factor in this system for thousands of years. Pyne and Sauer point out that the general use of fire was to replace forests with grasslands including evidence from the Chumash tribes of Southern California (Sauer, 1964; Pyne, 1980, 2016). Such benefits mirror applications within the rancho, ejido or traditional agriculture practices further South. Experiences with cyclical harvest or fires on grazing or "post-harvest" lands may be dependent on the degree to which traditional practices varied (Omer, 2002, Anderson, 2005) and the degree to which fire suppression and exclusion was practiced by subsequent landholders across these landscapes.

The question of labor, coerced, forced or otherwise, moved people over the land via transport networks. What constituted the labor force, and scale of transport is intertwined with global conflict. Conflict, war and the development of technical fire power has been discussed as key factors in the development of civilization and as a principal point of human societal transformation and decision (Diamond, J. 2005). Yet, at the beginning of any analysis of concepts of regional development and the links between the city and the country, the evolution of the city-state and principles of intensity of resource use, trade and external relations of the polity require an examination of the histories of movement of people, conflicts, migrations, resouce management and resource flows, including modes of transport and units of measure related to landscape and territorial transformation (Agnew, J. 1994,2013; Ostrom et al. 1990, 2005; Ehrlich, 1979, Laurie 1997, Mcwilliams, 1935).

A significant variable is the fire power both internalized, as in the Carnot cycle or the barrel of a Winchester rifle, or external fire that moved over landscapes both by the hand of humans and non-human natural forces. The use of fire is both cyclical and dynamic with long term effects of scale on our landscapes and societies. The traditional processes of agriculture, risks to settlements and habitual and ceremonial uses of fire are well documented and controversial as their use affects our economies, our cycles of work and daily life (Sauer, 1963; Pyne, 1997, 2015; Moritz, 2014; Stewart, 2002))

Building from the context of Bracero Burning in chapter one, the second chapter further discusses the mobility of labor, the economic and transport costs associated with operationalizing landscape management and frames the existing institutional discourses in the context of management of the commons. This framing suggests a modeling of labor over land that is necessary to address a more localized adaptive decision making informed by place based observations and diverse practices.

In this second chapter, a contemporary discussion of risk and energy systems modeling provides context for global assumptions in climate risk and the interaction with global biomass combustion. A look back at historical metrics of conveyance and normative private vehicle transport costs derived from literature, ethnographic work and historical methods of quantifying and modeling regional flows in goods and labor provides data for the development of theoretical models of biomass and labor transport over land. Data from this analysis include references from transport economics, geographic works that discuss historical and traditional landscape stewardship, practices and associated costs to provide basic normative assumptions in an applied geographic analysis of the spatial scale and economic costs of internalizing fire. Particular attention to labor time associated with the important questions of population distribution, transport and other operational costs of vegetation management and land stewardship are required in determining an operational scale of managing systems under risk of catastrophic fire.

The foundations of this research build from existing literature across the interdisciplinary fields of economic geography, fire ecology (fire science), and institutional analysis and local decision. This Chapter expands the historical economic geographic analysis of the first chapter into a dialogue of contemporary policies, institutional analysis and the theoretical scale of internalizing fire by looking at transport and operational decision models to examine questions of localized adaptive capacity. The central question of this Chapter engages interdisciplinary methods to investigate the role of distributed or local decision to explain the structure of “internalizing fire,” and whether local decision provides for a more adaptive response to future fire perturbations?

This chapter concludes by highlighting the need for additional research into the politics of practice as a mode of adaptive systems and consideration of related tradeoffs. While existing literature examines the interplay of forest management policy and density of biomass availability for combustion over this time period, more research is needed to understand the effects of large scale human migrations, labor mobility and operational tradeoffs in the context of a historic economic geography of the region during the contemporary period. Of critical importance to this work is investigating physical presence, regional and localized decision frameworks, frequency of the coupled human decisions of managing fire to ecological systems stability, which can be investigated by analysis of population distribution, transport infrastructure and the related costs and scale of mobility of people and production presented in the Labor over Land model.

Chapter three entitled Learning from a Manzanita Rising uses an indicator species widely associated with the landscapes of the Southwestern North America to provide perspective on motivations and opportunities for considering restoration in the context of the Labor over Land model and local decision framework discussed in Chapter 2. An important objective in the continual management of fire and ecosystems is to ensure accessible and localized food security for populations that face uncertainty from evolving natural and human caused food systems disruptions. The fire record in the Western United States and North America experienced a shift in the early 20th century linked to an expansion of large scale and centralized systems of agriculture, including forestry, driven by increased industrialization (Polanyi, 1944), as well as increases in population, labor migration and coupled shifts in intensity of land use and resource management (McWilliams, C. 1935; Laurie, B. 1997; Chang, 2019). In particular, shifts in forest and fire policy during this period had long term impacts on vegetation structure and operational systems that augmented and effected the density and availability of biomass and materials for combustion and conversion in a range of human use either in managed, controlled or unintended fire events, that in turn affected the range, presence and growth habit of the Manzanita.

Learning from a Manzanita Rising discusses the historical use of this plant as food, fuel, habitat and medicine among other uses and applies open source data in a spatial analysis to estimate costs an the potential operationalization based on availability of labor across California to manage and restore spaces where the Manzanita historically inhabited and where it has been identified and found today. A discussion of the related mutualisms of this species further delineates the important ecological niche and the way that the current structure and distribution of this plant interacts in the understory and across the landscape which impact fuel loading forest structure and other dynamics with potential impact on fire risk.

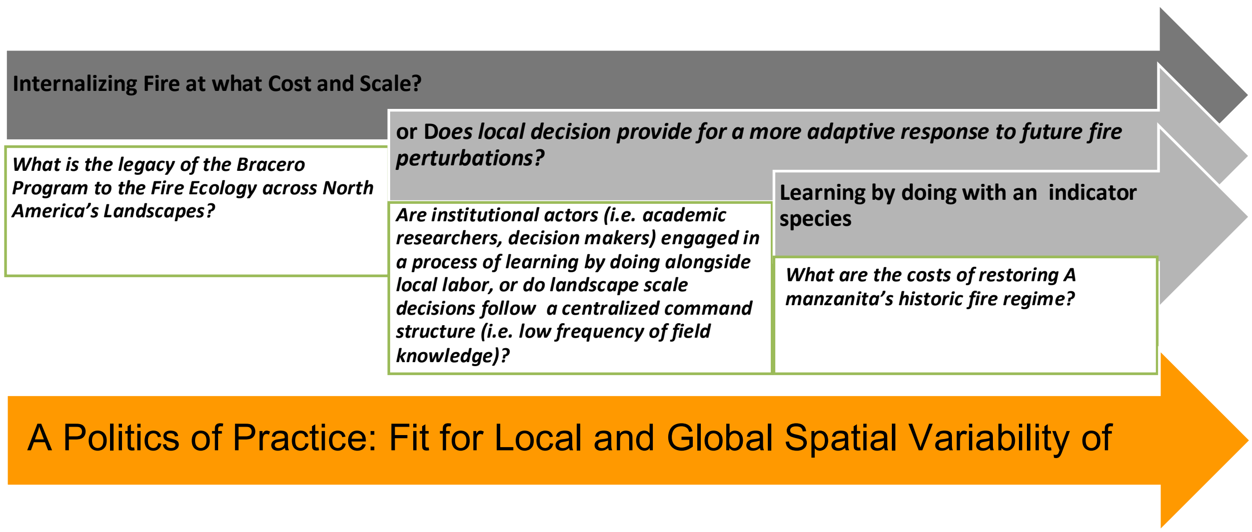
In the conclusion to this dissertation, the Politics of Practice, turns back to the framing in chapter two, informed by considerations and data provided throughout the dissertation to discuss a theoretical framing of decision and the identification of simple variables and practical models and cases that may be applied to the context in California for the continued long term stewardship of fire integrated landscapes. Here, applied theory of dynamic systems and discussion of the frequency of decision and the tradeoffs associated with local and global impacts engages in the application of a “Politics of Practice” fit for a new regionalism based on ecological foundations to effectively manage, in the face of fire perturbations, while considering the scale of related costs over time and space. Internalizing Fire at What Cost and Scale concludes with the theoretical identification of frequency of decision in a Politics of Practice and its relation to spatial variability, future policy and research directions for applied decision making.

Internalizing Fire at what Cost and Scale?

Effects of fire risk, decision and management are the result of long-term dynamic and interacting sociobiological functions over varying time and spatial scales. As a consequence, it is important to identify a period of time and space to conduct related research, while still addressing the dynamic and evolving context of these multiuse interactions (Berkes and Folfe, 1998; Berck, 1999). In the context of this dissertation, which seeks to provide a framework for examining economic and human factors in relation to fire management and land stewardship across scales, this analysis identifies the World War II Bracero program as a critical transformational period of human migrations in California’s history with subsequent long term impacts to California’s landscapes and neighboring regions. Regions that were a source and a “product” of this labor migration. In addition, this somewhat planned transformation (Polanyi, 1944; Mazoyer and Roudart, 2006; Graeber and Wengrow, 2021) contributed to a shifting and centralized agriculture structure that had significant knock-on effects across local and global fire geographies.

The central question of this dissertation engages interdisciplinary methods to investigate the role and impact of distributed or local decision to explain the structure of “internalizing fire,” or localized and indigenous knowledge, on a tractable landscape stewardship that works for ecological stability and adapting to a workable fire regime. In essence, ***does local decision provide for a more adaptive response to future fire perturbations?*** and hence provide for a more integrated ecology of human systems. With a requisite assumption that frequency of local interaction is important in knowledge development and in frequency of labor management, i.e. monitoring, planning, treatment, harvesting, resource management and adjustment, this dissertation establishes the theoretical framing for a Labor over Land (LOL) model and institutional analysis that may inform restoration of an ecology of integrated human systems in a more sustainable politics of practice, in a regional response, that is a better fit for the local and global spatial variability of Fire (Figure I1).

Figure I1. Internalizing Fire at What Cost and Scale?



Chapter One

Internalizing Fire: Bracero Burning and the Birth of Catastrophic Fire in California

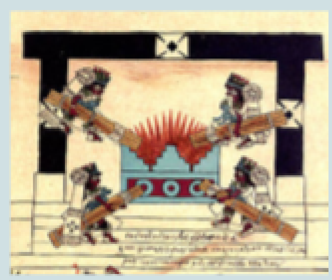
Abstract:

This Chapter examines an economic geography and historiography of Bracero Burning by engaging primary archived institutional data to examine the early motivation and administration of the Bracero program based on information available through the Online Archive of California and related Special Collections. Review of select Smithsonian Institutes archives and other oral narratives, which provides over 3000 personal accounts of Bracero's experience and additional supporting information. Further, interviews with researchers and academics and practitioners engaged in forest and fire management in Mexico and in California were also conducted, along with site visits and engagement in local and federal certifications for prescribed fire and other ethnographic work in the use of fire for indigenous and ecological management across public, private and ecological field research sites. These methods are further supplemented by review of the literature on migration labor, indigenous management practices and other scientific studies of fire ecological effects and use of fire across landscapes in North America.

Figure 1.2: Ancient fire and new fire - images depicting a global cycles of burning

Ancient aztec fire

A representation of the Aztec New Fire Ceremony from the Codex Borbonicus, held every 52 years as a new start of the Aztec century when the Sun and Moon cycles come together and all fire across the land was extinguished, until new fire was created with a fire drill with a "mamalhuatzli" wooden drill rubbed together in a ceremonial practice. Fire was then carried in the four cardinal directions. (Olvera, Fire Deities, 2001)



Ancient East Asian Fire

Representation of traditional Chinese characters Chun and Chiu from an etymology describing both the act of collecting bundles of grain or corn and then seasonally burning the fields after harvest the symbol for Autumn and an ancient and contemporary practice around the world. (Wieger, L. 1965)

Chapter One: Table of Contents

1.1 Bracero Burning: the birth of “Catastrophic fire” in California

During World War II with wartime labor shortages, growers and agriculturalists across California and other Western States in the United States of America developed The Bracero Program or the Mexican Farm Labor Agreement in collaboration with The Mexican government. The multi-objective program was developed in part to support food security during the war effort and support American agriculturalists, large growers and ranchers by filling the labor gap left by servicemen enlisted at the onset of the American engagement in World War II. At the time and in the aftermath of Pearl Harbor, Mexican officials promoted the program as a way to support the war effort against axis countries and provide job opportunities, economic development and international cash transfers in the form of remittances to rural and working communities in Mexico (Loza, 2016, Smithsonian Bracero History Archive).

The labor program led to a northern mass migration of Mexican campesinos and their families to the United States and a de facto decoupling of their daily labor from their lands of origination, traditional agriculture, and in cases indigenous land management practices, to work in higher intensity agriculture, ranches and domestic services throughout the American Southwest and beyond. This wartime migration also coincides with migrations from the United States South and East toward California as new entrants into these labor markets worked in the shipyards, aviation and other military and wartime industries that established new forms of labor flows, changes in working culture and the integration and segregation of new sources of labor across the American economy and communities for decades to follow (National Park, Rosie the Riveter Museum visit, 2022). A significant coincident factor also includes the internment and incarceration of Japanese Americans and other prisoners of war that were decoupled from their farms and trades and used as coerced labor during these periods (Ngai, 2004, Lebaron, 2019).

This Chapter investigates and provides context for this migration policy amid the history of the colonization of California and Indigenous groups of North America and related suppression of cultural and economic transformation of the uses of fire on the land. The Central theme and novel question posed is **What is the enduring impact and legacy of the Bracero Program to the Fire Ecology of North America?**

During this two-decade long policy and subsequent guest worker and seasonal labor program, families were separated for long periods, rights and abilities to engage in traditional and long term agriculture and land stewardship at the origination points were forfeited, and the perpetuation of historic labor inequities and exploitation of the rural or indigenous peoples of North America continued. Throughout this history and this economic geographic analysis the importance of systems of transport or “adequate transport” are examined in both a theoretical framing and a practical mode of labor operating across fields and across borders, later discussed in the “labor over land” model in Chapter two.

Chapter one of this dissertation establishes this framework, delves into a new historiography and economic geography of fire as a cultural and management tool on the landscape, and explores how this two decade long and seasonal migration from the Mexican interior of States (including Michoacán, Jalisco, Sinaloa, Durango, Aguas Calientes, Sonora and Chihuahua, among many others) resulted in a shift in the land management and fire regime, and the dramatic transformation of burning practices in agriculture, forestry, grazing and other fuel transformation across these geographies that led to the rise of “Catastrophic Fire” in California and elsewhere. Meanwhile some continuity in cyclical burning continued in Mexican regions to this day (Pyne, 2015).

By examining the legacy of this program in the context of longer term shifts in fire regimes, ecological and cultural practices linked to labor and land resource management through and prior to this period of 1942-1964, precedent and long reaching effects to our contemporary understanding of fire ecology emerge. Suggesting the interdependence of farm labor, labor migration and industrial fire as it exists today. Evidence to support this thesis is presented in an interdisciplinary framing of existing literature in anthropology and fire ecology, economic history and geography with the aid of oral histories, ethnographic research, open source spatial data and archival information. This work also grounds research questions in an operational space that holds important insight for landscape managers, practitioners and academics applying theoretical models to engage local histories, ecological data and additional interdisciplinary approaches in local decision-making. These insights are invaluable in framing adaptive capacity as we consider investments in biodiversity in the face of global change. This is further discussed in Chapter two and chapter three and the conclusion section of this dissertation.

Recent catastrophic wildfire events across North America, and in particular, events in California have compounded the complex challenges of addressing climate change and the coupled human ecology of landscape management. This has important implications for resource management that include forest and fire policy in the Western United States and beyond (Stephens and Ruth, 2005). In addition, the effects have led to expansion of risks posed by fire to the network of energy, transport and built human environment in an expanded fire season (Westerling et al, 2008). As the time scale, and frequency of fires has been augmented significantly in the 20th century, it is important to examine the complex interactions and fire histories including gaps in indigenous stewardship (Stephens, S. et al. 2023) that have led to the current state of affairs and a shifting ecological frame that is linked to historic land use, management and labor decisions and practices that have long been coupled and decoupled to cycles of indigenous burning and localized approaches to meet the resource needs and stewardship objectives of local peoples and neighboring communities (Anderson, K. 2005, Stewart, O. 2002; Biswell, 1999).

Omer Stewart along with other fire ecologists provide evidence that the records of indigenous people's setting fires throughout North America make it apparent that this activity was an important ecological factor in this system for thousands of years. Pyne and Sauer point out that the general use of fire was to replace forests with grasslands including evidence from the Chumash tribes of Southern California (Pyne, 1980; 2016, Stewart, 2002, Sauer, 1964). Such benefits mirror applications within the ejido, rancho or traditional agriculture practices further South. Experiences with cyclical harvest or fires on grazing or "post-harvest" lands may be dependent on the degree to which traditional practices varied (Stewart, 2002; Anderson, 2005) and the degree to which fire suppression and exclusion was practiced by landholders.

An important objective in the continual management of fire and ecosystems is to ensure accessible and localized food security for populations that face uncertainty from evolving natural and human caused food systems disruptions. The fire record in the Western United States and North America experienced a shift in the early 20th century that was caused by an expansion of large-scale and centralized systems of agriculture linked with increased industrialization (Polanyi, 1944), as well as increases in population, labor migration and coupled shifts in intensity of land use and resource management (McWilliams, 1935; Laurie, 1997; Chiang, 2019). In particular, shifts in forest and fire policy during this period had long term impacts on vegetation structure and operational systems that augmented and effected the density and availability of biomass and materials for combustion and conversion either in managed, controlled or unintended fire events (Pyne, 2015).

While existing literature examines the interplay of forest management policy and density of biomass availability for combustion over this time period, more research is needed to understand the effects of large scale human migrations, labor mobility and operational tradeoffs in the context of the historic economic geography of the region during this time period. This dissertation seeks to contribute to the social science literature by investigating a specific labor policy, in the context of historic labor migrations in California and address related questions in the fire ecology and management literature that can provide a more accurate understanding of the impact of human migrations to the fire ecology across North America's Landscapes. Of critical importance to this work is investigating existing literature for evidence on the effects of physical presence, in this context, the presence of a labor work force and frequency of the coupled human decisions of managing fire to ecological systems stability and the effects of local decision to complex systems structures in the face of fire.

As these guest worker agreements continue in some form to the present day, this chapter develops a historiography of this period and situates this question within the literature on labor migrations, California's economic history and the knowledge of indigenous landscape stewardship. Throughout this dissertation questions related to the type, mode and adequacy of transport systems provide context for understanding how labor moved over land and determined the type of knowledge systems and manual labor deployed over this and subsequent periods.

1.2 A brief overview of migrations, traditional biomass burning and culture of fire

Availability of plant, biomass, and other organic matter for food fuel and fiber or generally "fuels" for living, have an impact on fire effects across landscapes. Human uses and management are a critical variable in the spread of fire across the landscape. Fuels exist in and as part of complex and dynamic environments that change depending on temporal and seasonal effects, vegetation type, existing structure, climate and water system variation, and the interaction with humans and other fauna. An expanding variety of approaches are used to identify, observe, characterize and monitor fuel conditions and map them and their interactions with fire effects, management, conservation and other scientific and human uses, including the decision of how, when and where fuel treatment may be applied (Stephens and Ruth, 2005; Pyne, 2015, Roos et al. 2014). As well as understanding how these interactions evolved over time through a variety of methods across the social and natural sciences and humanities. These histories of fire use have been developed from oral narrative, physical science experiments, direct observation and many other archeological and related methods in practice (Stewart, 2002 Anderson, 2005). What we have learned as it relates to the historic context of this dissertation can not be easily distilled into the confines of this work, however a brief history of these cyclical and dynamic processes are attempted hereafter.

Fuel cycling or fuel combustion has been a fundamental process since time immemorial and varies by vegetation type, conditions, legacies of management and the culture of practice or cultural DNA of overlapping complex systems (Berkes, 2008, Berkes and Folke 1998). Fire can be at once primeval, necessary, problematic and "sacred", it provides benefits and costs at different times and through augmenting feedback cycles with difficult to quantify ecological effects and human cultural, social and economic effects (Lake 2017, Stewart, 2002, Pyne, 2015 Stephens et al. 2023). Recent scientific analysis and archeological records in California are undergoing a reexamination and new methods and applications to detect signals and information that are useful to piece together moments in time and space that can tell us more about the history and culture of Fire in California and across North America (Fossum et al, 2024 Stephens et al

2023). Beginning with the work of Omer Stewart, Harold Biswell, Kat Anderson and others including Stephen Pyne we may begin to piece together a pre bracero history that offers a narrative in line with the events and recorded histories and data that are currently available. The Oral narrative of many landscape managers, native and indigenous tribal communities also compliment these histories to bring us more data that fills the gaps that exist in direct scientific observation.

An examination of California's agriculture migration history and the impacts of the landscape and fire ecology across North American landscapes relevant to the later Bracero period of wartime labor migration policy, must begin with the a history of people in the places and spaces that the Braceros occupied and the spaces and places they left behind. While the related labor flows impacted wide regions of Western North America during this time, this history will focus on that of California. The focus of this history begins with 1846 the year the Bear Flag Revolt occurred in Sonoma and ushered in the transformation of California to The United States of America. This history is dependent on effects farther afield in Texas and across broader regions dominated by historic cattle grazing. The focus on the wartime immigration policies of the Bracero program, earlier histories of labor, immigration, coerced labor and incarceration and the waves of exclusion and subsequent inclusion in California's history are essential and part of contemporary dialogues that affect California politics today. Histories of land use decision-making and perspectives leading to continuation of forced labor policies, housing availability and also the development of a common culture engages with the evolution of California's "mythical" landscapes (Rothstein, 2017, Dana and Krueger, 1958, Mora, 1949, Nakano, 2002).

While the work of others may be better suited to providing more in depth information of the Native and indigenous burning that happened in the spaces now called California, recent narratives from many indigenous tribal communities emphasize the significance and some limitations of Stewarts work in Forgotten Fires and the importance of Anderson's "Tending the Wild" in relation to understanding processes we observe in dendrochronological and archeological records in California, and elsewhere, that point to the routine and cyclical nature of burning landscapes for food, fodder and fiber, and other practical and ceremonial processes.

As Berkes and Davidson Hunt 2006 and Lake et al 2017 establish, that while indigenous communities may favor a more heterogeneous and resilient landscape that absorbs and fosters adaptability to wide ranging events, drought, water resource availability, food production, views from industrial agriculture as "centers of enterprise" with remote managers that favor intensification of commodity or experience may not value the "open" forests and the degree to which fire may need to be provisioned (Pyne, 2015, 2016). As socio-ecological landscapes have continued to be impacted by overlapping tenure, complicated historic property rights and overlapping jurisdictions, land use practices, fire suppression, fire exclusion, industrial forest management and top-down decision processes including trade and labor migration policies - the broad consideration of how to reintroduce prescribed, controlled, and cultural fire in an adaptive context to the time remains a question concerning the distribution and availability of labor on the landscape.

Figure 1.3. highlights a very recent discussion in the Sonoma County Press Democrat reprinted from an Los Angeles Times article on the historic use of forced inmate labor used to fight fires and tend to landscapes across California in recent decades. As Californians seek to vote and consider the use of labor in clean energy materials globally and on the landscape in California, the reality of managing fire has fire agencies discussing the usefulness of having repopulation of the landscape and the local monitoring of conditions by local residents to free up their own staff to manage other priorities. These are very real concerns highlighted in the aftermath of another “catastrophic fire” season in California in news print on the same page as the discussion of prison labor used in wildfire management. In California the Black and Latino/native population make up a disproportionate population in the prison system and hence such forced labor policies call up memories and histories of racial discrimination, coerced migration, racial profiling and other social and criminal justice issues, including where and how people have access to public lands, recreation, housing and the multiple benefits of parks and natural amenities (Rothstein, 2017). In the 2021 book Breathing fire Lowe discusses the hardship conditions of female inmate firefighters in California and the tough transition with low compensation that these and other inmate labor have experienced in contemporary use of prison labor on the land.

Figure 1.3. California to Vote on the end of forced Labor? More Catastrophic Fire?


State may end forced labor

FIRE

The Press Democrat, Thursday, June 20, 2024 (Anabel Sosa Los Angeles Times)

In the local news: Two stories on the same page coming together on forced labor and fire.

“California lawmakers have revived a proposal that could ask voters to ban involuntary servitude from the state Constitution, a measure they rejected two years ago amid concerns over the cost of paying prisoners higher wages for the work they do behind bars.”

“California is one of 16 states whose state constitution allows forced labor in prisons. Some prison workers make as little as 8 cents an hour..”

“Right now , about 40 percent of the 93,000 inmates in California’s prisons have jobs, including janitorial work, kitchen duty, clerking and fighting fires in the wild, one of the most physically intensive and highest-paid positions.”

After recent Sonoma County fires… officials say…

“But there’s also benefit to having people back in the area…”

“We want people to get back because that means more eyes on the landscape…they’re actually a help, because then you have less need for police officers to hold lines and hold access all night, so they can go do other work.

Repopulation is a topic of discussion today,” “we are working with all the partners in the infrastructure team - roads,power, all the cables, all thewires and stuff - and making sure that they’re ready to go, the roads are safe, there’s no tree negation that needs to be done, that Cal Fire doesn’t have more work to do.”

…nearly three times more acreage burn in the past three days than in the past three years combined, when the region got a break from major wildfires after consecutive years of catastrophic fire.”

As California grapples with these socioeconomic realities in the face of fire, efforts to document, revitalize, learn and share traditional practices globally and expand local field knowledge and practices are active across North America. That requires a culture of inclusion of people with knowledge in the field regardless of their social rank to relearn the coupled requirements and capacities of fire on the land. Having people on the land and knowledge of local ecological systems is an expanding and active area of research from the ground up and across disciplines. The histories of land access, grazing rights and the application of cattle, sheep and goats as vegetation management have been recently increased in California in some instances with migrant labor coming from Mexico, Central and South America where shepherds skills have been continuous. The concepts of transhumance, the movement of grazing livestock and people across the lands have been recently resurrected in festivals and practice in California including in Sonoma, Marin and other counties.

In North America, as in other parts of the world, the roots, science and arts of Transhumance is one critical area of focus for the knowledge of these traditions of fire, by hand, by campfire and by cultural expression. As transhumance has become mechanized, ranchers and pastoralists with knowledge of fire have lost out to the “centers of enterprise” as Pyne discusses in Pastures of Purgatory, a California Fire Survey, but these processes are evident across broader geographies (Pyne, 2016).

Recent work by Martinez Torres in 2019 in his Universidad Nacional Autonoma de Mexico, Phd Thesis, working in the Reserva Biosfera Mariposa Monarchas (RBMM) with indigenous groups and across ejido and tenured management boundaries in this conservation setting, provide a case for the challenges, opportunities and coupled human ecological systems that cross boundaries and have import for the future response of complex adaptive systems responding to both environmental and human pressure shifts. Martinez Torres’s work documents traditional fire practices and the reintroduction of these practices more broadly to respond to ecological risks affecting Monarch butterfly populations in their overwintering spots in the Forest and mountains of Central Mexico and specifically in the States of Michoacán and the Estado de México. This is just one contemporary example of building trust and learning across cultures of fire in North America.

1.3 Fire systems and signals of California colonization and forced migration

Beginning with the Spanish period from accounts of the Missionary Juan Crespi’s expedition through California (1767) and prior periods of Spanish conquest, local Indigenous populations throughout California provided labor for the Missions and Spanish landholders (Fages, 1972). This labor included many practices, skills and trades introduced by the Europeans including the suppression and exclusion of fire in agricultural and land stewardship practices. These practices included tending to cattle, sheep and goat grazing lands and other high value crops including viticulture and other labor-intensive food and fiber production.

The economic activities benefiting the heads and families of these enterprises during historic and by some measure up to the contemporary periods, are evidenced in California by Kat Anderson's work and reference to 1812 letters of "very substantial profits" from sale of Indian labor products. According to Anderson, garrisons, presidios, missions and wealthy families benefited from an underpaid and compulsory labor force.

Additionally, the benefit of local resources and local or traditional ecological knowledge that manifested in resilient food sources during times of scarcity and the use of health and medicinal plants are still documented by the names given by the Spanish (Anderson, 2005). Others including Timbrook, Bean and Lawton further hypothesize that the rise of cultural complexity in indigenous California burning was an approach to food production more efficient than agriculture in this ecological setting. During the mission and later periods foraging and gathering with traditional practices and land stewardship enabled managing the complexity and uncertainty of these changing systems, which could not continue with increased fire suppression (Bean and Lawton, 1973; Timbrook 1982).

This well documented history of a cultural decimation, brutality and labor exploitation of the peoples of the region, while the ecological systems benefits were enjoyed by landholders and an elite class are further compounded by the long-term fire suppression and exclusionary policies since this period, that have led to contemporary dialogues on reframing ecological stability, social justice and resilience across academic disciplines. The traditional practices across the region stemming from cyclical human ignitions and burning in a cycle of food production, mobility, safety and other coupled socio-ecological experience had been lost. Replaced with an increasingly expanded void of understanding and behavior out of synchronization with the responsibilities and requirements of previous occupants and land stewards long coupled with the ecological systems processes (Berkes, 2008).

These dialogues represent a void in North America's Fire History. In response, efforts exist to fill the void and piece this history together in varying approaches. The reliance on oral histories and traditional means of storytelling is one way that the knowledge is being redeveloped and recorded to point towards additional ways of knowing through scientific experimentation and wider knowledge development.

The historic early colonial demands of the "new economy" in California again demanded continuous labor inputs during the mid 20th century for food production and wealth creation. Anderson discusses the similar historic disenfranchisement of Indian Labor on their own lands with little recourse than to work for Euro-American settlers. Forced to accept "low wages of forced labor of a new economy where they cut timber, maintained railroads, picked crops… washed clothes, built structures, and served meals and other domestic labor for white settlers" (Anderson, K. 2005). Meanwhile, the existing labor system was perpetuated by new entrants, in waves of migration with greater mobility than those already present with little recourse than to continue in the trap of low wage low return intensive agriculture.

Omer Stewart and other subsequent anthropologists and fire ecologists provide evidence that the records of indigenous people's setting fires throughout North America make it apparent that this activity was an important ecological factor in this system for thousands of years. Pyne and Sauer point out that the general use of fire was to replace forests with grasslands including evidence from the Chumash tribes of Southern California (Pyne, 1980, 2016, Stewart, 2002). Such benefits mirror applications within the Rancho or traditional agriculture practices further South. Experiences with cyclical harvest or fires on grazing or "post-harvest" lands may be dependent on the degree to which traditional practices varied (Stewart, 2002, Anderson, 2005) and the degree to which fire suppression and exclusion was practiced by landholders.

The "Rancho culture" during the period of colonization providing abundance to the land owners and their families was contingent on the existing and prior labor of the indigenous people, vaqueros and long held traditions of stewardship that provided the abundant water, grass and resources with ample grazing lands for profitable cattle and agriculture operations. William Garner's account provides further evidence following his emigration from England of the toil of the Indian population, benefiting the California rancher's beautiful large tracts of land (1846) with little to no compensation (Garner, 1970). Accounts of other immigrant populations arriving in California at the time of the Californios and adopting the existing labor system can be found in the Vallejo Papers at the Bancroft library.

During the Spanish and later Mexican period the system of peonage of a labor force exchanging their work for their home, food and commodities with benefits given at the discretion of the landowner or employer. Anderson lists the tasks as shearing the sheep, herding cattle, cutting lumber, harvesting crops, pounding the grain into flour, building houses, tanning hides, cleaning houses, serving meals and making tiles and adobe. This example of historic peonage faced by indigenous people of the mission period including those at Mission San Juan Bautista provide historic parallel to those practices documented during the Bracero program, almost a century later and subsequent periods related to guest worker or exploitation of undocumented workers. The era of fire exclusion and later fire suppression across landholder geographies and subsequent deprivation of an "efficient good servant" in fire at the expense of expanding back breaking work and subsequent suffering of laborers had coupled ecological effects and environmental damage due to this intensification.

Anderson further accounts for environmental change during the Mexican period with overgrazing and expanding herd size into California's Central Valley further stressed water and vegetation resources. Other coastal resources and wildlife were further stressed through fur trapping, overhunting, timber, fuel and oak harvesting. Similar impacts to native grasses as Native food source and forage began to be stressed (Dartt and Newton, 2006). By the early 20th century a survey of the San Joaquin Valley and surrounding areas found that the majority of grassland, woodland and chaparral was dominated by “invasive” and introduced species. Similar impacts occurred across Mexico and Latin America after Spanish Colonization .

The narrative of ecological factors that are leading to the assimilation and adoption of mission and more intense agriculture systems, paint the colonial powers as saviors to the labor, slave and indigenous peoples. While, the constant flow of feed, labor and resource into these centers of trade diminishes the ability for the local village practice or traditional or cultural practice to continue, the policy mandates underpin a notion that the dense urban or centers of enterprise are more resilient than the distributed village life that for instance the Chumash had successfully navigated in California’s coastal and Mediterranean ecosystems. The contemporary dialogue related to California’s current wildfire events echo these notions of lack of resilience in distributed village - wildland interface systems. Yet this notion fundamentally sidesteps the impacts of cyclical fire dynamics at the landscape scale that had been managed through traditional practice over millennia.

Other accounts from the Spanish expeditions of Cabrillo have documented widespread use of fires and vast smoke plumes across the landscape (Cutthrell, Fall 2021 Uc Berkeley Lecture). The name originally offered to the Santa Monica Bay was Bahia de los Fuegos/Fumos or “land of many smokes.” (Mcnary, 1931). The introduction of peonage agriculture during the mission period also changed the cycles of burning as livestock, intensified farming practices of the Spanish and the Mexican periods preserved grazing lands with introduced seed to secure forage for the thousands of cattle that grazed previously burned pastures and meadows, that indigenous cultures depended on for hunting and foraging. Livestock densification had a significant impact on the foodways and waterways of indigenous ancestors that used acorns, wild seeds and other medicinal plants and basket weaving fibers (Corina Gould Fall 2021, UC Berkeley Lecture).

Following the Treaty of Guadalupe Hidalgo that ended the Mexican American war, efforts in California continued to attempt to eradicate local indigenous populations including an account of California budgeting $1.4 million dollars at the time to be paid for the heads and ears of the california Indian populations at a rate of $5 per head and $0.25 cents and ear (Corina Gould and Valentin Lopez, UC Berkeley Lectures Fall 2021). These and other land policies including the Settler’s Act led to the widespread destruction of native peoples, their family units and tribes and the culture of nomadic peoples in North America. Some scholars point to a map created by Nells Nelson 1909 as a reference to the movements of tribes prior to the occupation by European and other settlers. Many native peoples learned spanish and blended between cultures of farmwork, including accounts of the neophyte Estanislao, for which the Stanislaus River is named, who both worked with the Fathers in the Missions and also led worker struggles against the treatment of the native populations in early California history.

The role of the early Californios in Mexican American history can also shed light on the nature of this assimilation and the pressures facing both the Native and later Spanish speaking Californio population following statehood. Following the arrest and short incarceration of the Mexican General Vallejo by John C. Fremont at Sutter's Mill in 1847, Vallejo, a supporter of American interests in California and saw the introduced cultures of the American and European settlers to California as a benefit to the future of the State and development of resources, oversaw the transition towards California as one of the United States (Rolle, 1995). In his earlier years, Vallejo had made his mark leading campaigns against indigenous populations in Northern California and putting down native people uprisings, at the intersection of empires from his vantage in Sonoma and Monterey (Rolle, 1995; Vallejo Papers, Bancroft Library).

A historical account of Vallejo also offers his struggle following the Bear Flag Revolt in managing between new settlers, the controversial United States Military actions under the unofficial orders of John C. Fremont and the challenge faced by discrimination of Californios that became Americans, in losing their language, culture and transitioning to the massive migration influx over subsequent periods from the Gold Rush and later waves of migration, with both forced and recruited labor from China, Japan and other waves of European settlement, including the Irish Famine. In fact, the balancing act between cultures that Vallejo experienced can be observed in the choices of his sons, one adopted and estranged from a mistress of indigenous roots, that later rejected his father's political stances and the other who served as a medic during the United States Civil War and later returned to California where he penned a dictionary of the Suisun language and was active in building friendly relations with indigenous communities in the California Delta region. Throughout this period the suppression of indigenous burning, the intensification of cattle grazing, the influx and migrants to California and the subsequent extractive agriculture, industrial and related revolutions in mechanized transport altered the California landscape, waterways and relationship with California's natural resources (Dartt-Newton, and Erlandson, 2006)).

Later periods of migrant arrivals from Asia including Chinese railroad workers further exacerbated the xenophobic and discriminatory actions against cultural practices and uses of the landscape that were brought with them. At times these migrants found connection between and across the indigenous communities that survived in California (Chang, 2019). Accounts of sharing foraged food, traditional medicinal practices and social and cultural connections in pastimes, architecture and foodways are documented in the literature and in existing archeological sites across Northern California, the Sierras and the Delta regions where many of these communities found a footing (Ngai, 2004; Chang, 2019).

What existed prior to California's naming was a landscape that entered the European imagination and conception from the perspective of the South, while earlier migrations from the borders of the Pacific Ocean during the ice age allude to an evolving understanding of multiple nations and multiple spaces in sequential occupation and nomadism that (Graeber and Wengrow, 2022; Rezendez, 2016.) culminated in the pre-Spanish conquest period with an interrelated and interdependence of diverse peoples across diverse landscapes that managed cycles of disturbance and renewal for millennia.

California's history begins with the mythical reference to the land of the Gaul's from the fictional account of California's namesake, understood by sailors in the 17th Century as a Utopian Paradise that may have lured or occupied the minds and early voyagers across the Atlantic when it was first published in 1591. The waves of immigration and settlement to follow would further reinforce and propagate these ideas of this "land of opportunity and abundance."

The displacement and forced labor, cultural and physical genocide of Native populations and indigenous cultures that occupied these places for millennium prior to the European Conquest established a transformation in the natural systems, that are augmented in a sense by the socio-cultural connections to these systems and cycles over long periods - that are today recognized by diverse perspectives as the torchbearers of stewardship, land-based labor, management and place-based decision that have co-created these landscapes that may have inspired such applications in naming as Los Angeles, Monterey, Loma Linda, (Mcnary, 1931) among many other early Spanish nomenclature.

Following the Mexican War of Independence from Spain in 1824 and the subsequent secularization of California's Mission System with the last Mission at Sonoma de Solano completed in 1828, the history of Mariano Vallejo follows from early Californios participating in campaigns against indigenous peoples. For Vallejo, who was a pivotal figure in the transition from the Spanish Mission system of indigenous labor, to the Mexican secularization of the Mission labor system to the large Rancho-style indigenous labor system the large land systems management and efforts to fend off European and American Imperial interests in Northern California led to consistent efforts to promote the type of arrivals, settlement and welcome emigrants that would continue to develop his and other Californios' vision for his home (Vallejo Papers, Bancroft Library; Rolle, 1995). This included the continued reliance on indigenous labor and the perpetuation of discrimination and harassment that native peoples had struggled with since the earliest encounters with Drake and Spanish explorers.

In the 1830s as a young leader at the Frontier of the Mexican Empire, Vallejo was also challenged by the border skirmishes and Statecraft that included developments in Texas State formation (Torres, 2001) and the questions of both indigenous and imported forced labor underpinning the resolution of Mexico's infighting that was representative of the nascent Mexican State at that time. This included decimation of Bands of the Miwok, Ohlone, Pomo and Wappo and Yokuts cultures around the vicinity of the Northern California Bay region and Central Valley, among the thousands of indigenous language cultures and communities across North American landscapes, and the intense resource use and extraction of materials to offer international markets.

Later, when new arrivals brought traditional practices, such as Yakihata burning practices of Japanese traditions, these practices were also extinguished. This style of Japanese swidden agriculture which was once practiced in temperate Japan featured cultivation primarily of millet, and was characterized by highly sophisticated and complex cropping systems according to the natural environment, which varied from one region to another. In the 1970s, however, swidden agriculture which had been continuously practiced as a primary means of subsistence in mountainous areas of Japan ceased to exist. Accordingly, a scholarly review includes studies from the 1950s to 1970s, the post-war period in which a large number of research findings were produced from the perspectives of the humanities and natural sciences. This tradition and techniques followed in other Asian small-holder systems provide context for the impending internment of Japanese Families during WWII forced to relocate from small farms to a prison system that used their labor as prisoners of war during the Bracero period.The prewar backdrop of these forced migrations is further illuminated in the work that Karl Sauer at UC Berkeley and Karl Aldridge at Stanford conducted for the War Department and other agencies in advance of WWII (Karl Sauer Papers, Bancroft Library, Karl Aldridge Papers, Stanford Special collections.)

In Hidetaka's book, Expelling the Poor, he discusses the immigration policies of the 1860s in the context of civil war policies that established the Homestead act which provided for a settler established land grant of 160 acres and further developed the context for later exclusionary policies such as the Chinese exclusion act and the post-civil war immigration policies that set the course for the know-nothing and exclusionary policies of the following decades. The Irish that were sent to labor during the Civil War underpinned the war effort and industrial processes that enabled the machinery of war that led to The Union armies victory over the Southern confederate States. The role of the farm laborers and subsequent factory labor that drove the industrial revolution and expanding economic power in the United States further exacerbated and led to conflict at the US Mexico Border and historical economic and power disparities between the United States and Mexico (Frazier, 1998). This along with continuous cycles of forced migration and removal in other parts of the world contributed to the California migratory and farmworker conflicts in the early 20th century documented by Steinbech and others.

> *"Contrary to state officials' claims of humane and consensual removal, the expansion of their authority over immigration fostered coercive and illegal expulsion, with some paupers virtually kidnapped from charitable institutions and some citizens banished abroad. Driven by anti-Irish sentiment, state-level immigration control operated in ways that allowed officials to exert tremendous power over objectionable foreigners and disregard their basic rights and protection in the execution of laws." (Hirota, Expelling the poor, 2017)*

Considering this policy context in the later era of the Mexican government's promotion of the Bracero program, and antecedent program during World War I, the consequences of moving people from their land, "expelling the poor" or accommodating historic challenges following land reforms or institutional challenges after the Mexican Revolution in 1911 are also precedent. In the context of the role of the Spanish in California in the preceding century, the movement of rural villages to "centers of enterprise", urbanization and agricultural intensification in California are seemingly familiar.

1.4 Emerging gaps in "labor on the land": The extraction of resources and local decision

Pre-existing conditions and the need for continuing labor inputs to offset the declining resource efficiency due to imbalanced land tenure are discussed by Johnson in John Muir's legacy in Yosemite in Fire over Ahwahnee, as a continuous need for recruitment of Indian labor to facilitate nearby ranching and agricultural work (Johnson, 2014). Earlier, the 1803 decree by the Spanish Viceroy moved Indigenous groups from their villages to the densely populated missions. In the context of these migrations from rural to dense urban dwellings, drought or other environmental events have been discussed as the cause, including in mid 20th century migrations from the South. However, in this instance Gibson in Aztecs under Spanish Rule attributes this movement directly to the process of Colonialism (Gibson, 2014). While the constant inflow of labor was an essential quality of the California experience from the beginning of United States Statehood, the control and restriction and recruitment of that labor ebbed and flowed with geopolitical developments and the rise of the industrial city and expanded transportation networks and infrastructure including a rail network built for extraction.

The restrictions of the migrant labor force imposed by the availability or lack of transport to housing and infrastructure during these periods of migrant labor caused a marked change from the open landscapes and cultural practices and traditions that Braceros had experienced in their locations of origins. The all-male labor force also caused additional stresses and estrangement from their homes and families. Many Braceros founded new partners or families and abandoned ties and connections to their families and communities far away (Bracero Archive). The seasonal traffic between locations led to the neglect or lack of "eyes on" the lands of origin and an ecology that had been developed as part of the historic family labor and community connections to those landscapes.

In 1944, early on in the Bracero program, approximately 6000 Braceros went missing, returned to their estranged homeland or decided to not fulfill their contracts. The abandonment to California growers during this period caused concern within the Farm Security Administration, which sought to shore up the administration's management and oversight of the worker placements and address some key issues that Braceros faced in their placements. The repetitive nature of the tasks and shift from the small parcel to large industrial farming operations took a toll on the health and wellbeing of Braceros as they were forced to engage in repetitive and assigned tasks under direction of labor supervisors rather than the individually motivated, cooperative, socially and community motivated priorities of traditional or rancho style systems in their hometowns (Raymond Roth Papers; Grove, 1996).

While all braceros did not arrive from the campo or rural areas of Mexico, some originating in the urban enclaves of Central or Northern Mexico. With this estrangement from their traditional landscapes, the seasonal routines and the labor in family parcels was either neglected or led to a loss of tenure based on land use and active presence in those parcels. These circumstances led to gaps in ownership and continued transformation of the Mexican landscape to an urban migration and consolidation of farms and agricultural interests. This WWII consolidation was just the latest in a long history in the post conquest period of land tenure decisions that favored the ruling, Spanish or wealthy mestizo classes over the traditional and indigenous farm laborer (Guerin Gonzalez,1996).

It follows that the motivation to learn advanced technology and the subsequent adoption of fertilizers and industrial chemicals mirrored the loss of animal husbandry and the approaches of applied burning in the cycle of nutrients within and across the regions and landscapes.

1.5 A Pre-war planning to propagate Latin American out-migration?

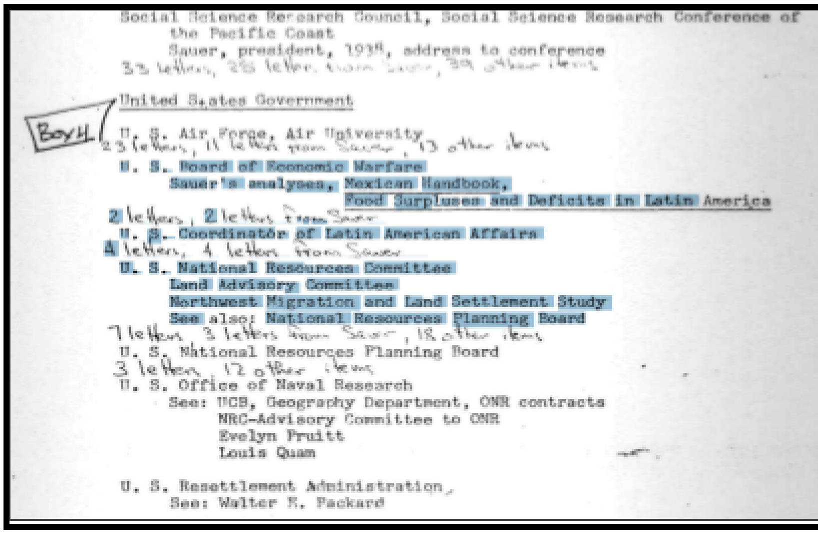
The expansion of migrant flows, transport systems and rise in industrial agriculture were coupled with a concerted effort by planners and the U.S. federal government to strategize an approach to continuing labor flows from the Americas in the prewar period. Depression era policies and New Deal infrastructure along with industrial policy in the South relied broadly on land and resource intensification. Meanwhile, anti-mexican sentiment characterized the writings of American academics of the time. Carl Sauer, a founder of the University of California Geography department in a letter to Karl Aldridge at Stanford stated in the context of the Mexicanization of the "Indian" "I am all for the Indian" (Carl Sauer Papers, Bancroft Library). These contradictions and characterizations of struggles between what is Indian, Native American and Mexican continue to be subjects of debate in academic and societal discourses related to fire today.

Sauer who had traveled extensively in Mexico had written in his Book, Land and Life, on the importance of locomotion and population distributions in the cultivation of maize and other varieties of indigenous crops.

> *"Locomotion should be slow, the slower the better, to stop at vantage points and question marks." - Karl Sauer, Land and Life*

Yet, in contradiction to such sentiment and academic pursuit of localism and the importance of indigenous livelihoods and food ways including use of small Milpa and Caiginga principles of traditional cultivation, including burning practices, he nonetheless provides counsel to the U.S. War Department on the status of surplus labor throughout Latin America that may be extracted and used in the context of food security in the Americas during the wartime. In his comments on the studies highlighted in Figure 1.4. Sauer characterizes potential for a mobile workforce that could benefit the increasing demand for an industrial agriculture workforce in the North, in an analysis of the redistribution of "surplus" labor and resettlement across the Americas.

Figure 1.4. University of California Perspectives on Latin American surplus labor


Social Science Research Council, Social Science Research Conference of the Pacific Coast
Sauer, president, 1938, address to conference
33 letters, 28 letters from Sauer, 39 other items

Box 4
United States Government
U. S. Air Force, Air University
23 letters, 11 letters from Sauer, 13 other items
U. S. Board of Economic Warfare
Sauer's analyses, Mexican Handbook,
Food Surpluses and Deficits in Latin America
2 letters, 2 letters from Sauer
U. S. Coordinator of Latin American Affairs
4 letters, 4 letters from Sauer
U. S. National Resources Committee
Land Advisory Committee
Northwest Migration and Land Settlement Study
See also: National Resources Planning Board
7 letters, 3 letters from Sauer, 18 other items
U. S. National Resources Planning Board
3 letters, 12 other items
U. S. Office of Naval Research
See: UCB, Geography Department, ONR contracts
NRC-Advisory Committee to ONR
Evelyn Pruitt
Louis Quam

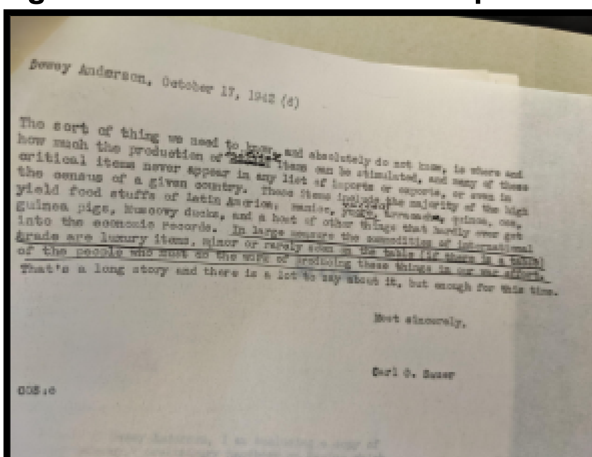
U. S. Resettlement Administration
See: Walter E. Packard

The Catalogue of the Carl Sauer Papers at the UC Berkeley Bancroft Library show correspondence and advice given by UC Berkeley Faculty on the stopics of surplus labor, food and resource security in the United States and the potential to extract surplus labor from the South, particularly in Mexico yet also further across Latin America. This correspondence was part of prewar planning and a counter to resource disruptions from Asia during Japan's territorial advancements.

Source: Bancroft Special Collection UC Berkeley, Carl Sauer Papers

His comments and advice on these reports and corresponding letters demonstrate a contradiction in the availability of labor to meet the needs of international trade, economic development and the wartime food supply for the United States and allied forces at the expense of local culture, food ways and livelihood and traditional land practices across Mexico and Latin America. These reports and Sauers' reflections point to an orchestrated process to transform food production and the availability of labor on the land to meet demands of the US government at the time and labor requirements for a more industrial workforce that may be resettled to work in farms and industrial production across the Americas to the benefit of consolidated growers. Figure 1.5. highlights that sentiment in a letter to Dewey Anderson where he states that the current food production and application of labor is not currently meeting needs in the United States and these "people…must do the work of producing these things in our war effort."

Figure 1.5. Sauer on local food production in Latin America and the labor supply



"…In large measure the commodities of international trade are luxury items, minor or rarely seen at the table (if there is a table of the people who must do the work of producing these things in our war effort. "

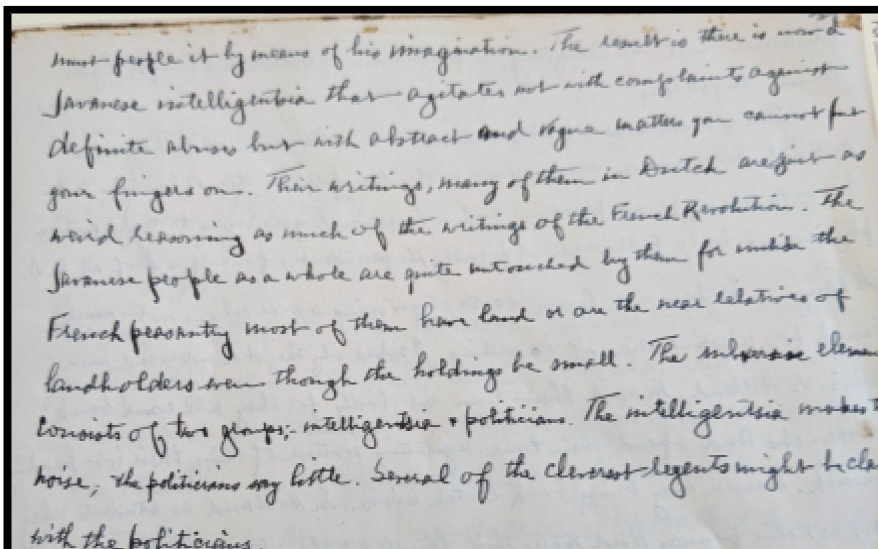
Carl Sauer in a letter on the labor surplus and deficits of Latin America to Dewey Anderson October 17, 1942.

Source: Carl Sauer Papers, Bancroft Special Collections, UC Berkeley

Sauer's later correspondence with Professor Knight, at the University of Chicago and Lewis Mumford President of the American Academy of Sciences and others in the post war period later demonstrate a sense of loss or nostalgia for a bygone era that has been lost to the industrialization of War and the overreliance and dependence on data and computation at the cost of the values he earlier put forward in Land and Life. As an aside, in the 1950's one of Sauer's contemporaries, Harold Biswell, a founder of fire ecology at UC Berkeley asks Sauer to comment on his work "Big Trees and Fire and questions of lightning fire" and mass migrations from Asia in the last ice age. No response or further correspondence between Sauer and Biswell was found to be included here and perhaps Sauer neglected engaging on the more contemporary questions of fire on the California Landscape during the 1950s when the Bracero period was active.

While, Sauer puts forward the possibility in his earlier works in Origins and Distributions and Grassland Fire that the periodic and cultural burning was instrumental in shaping the landscapes from much earlier points in overland migrations from Asia, the discord that appears in his support of institutional policies to counteract small holder or ejido systems points to an apparent value contradiction of the period. His correspondence in the 1930s with Karl Aldridge, the founder of the Stanford Food Institute further demonstrates this contradiction. The works of Aldridge himself point to this extractive mindset as he comments on the knowledge systems of Copia growers and the availability of tradeable and exportable commodities during his meetings with doctors, businessmen and academics in the Asia Pacific region. The bias towards a western colonial mindset of both Sauer and Aldridge, may be highlighted in Aldridge's notes from his trip to Java. Reporting on the abstract and vague complaints that are reported by local Dutch administrators of the native Javanese, Figure 1.6.

Figure 1.6. Stanford Food Institute's Aldridge comment on Javanese worker resistance


must people it by means of his imagination. The result is there is now a Javanese intelligentsia that agitates not with complaints against definite abuses but with abstract and vague matters you cannot put your fingers on. Their writings, many of them in Dutch are just as weird reasoning as much of the writings of the French Revolution. The Javanese people as a whole are quite untouched by them for unlike the French peasantry most of them have land or are the near relatives of landholders even though the holdings be small. The subversive element consists of two groups:- intelligentsia + politicians. The intelligentsia makes the noise, the politicians say little. Several of the cleverest regents might be cla
with the politicians.

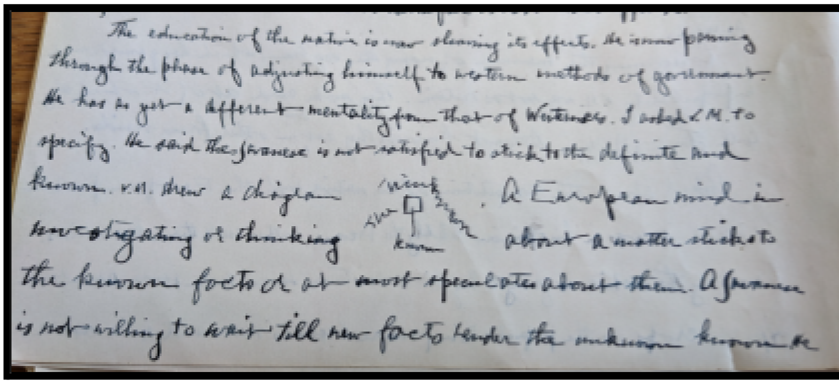
"Javanese intelligentsia that agitates not with complaints against definite abuses, but with abstract and vague matters you can not put your finger on. Their writings … are just as weird reasoning as that of the French Revolution."

- Karl Aldridge, Stanford Professor of the Food Institute, Circa 1930

Source: Karl Aldridge Papers, Stanford Special Collections

This “Colonial Californian” academic culture is further reinforced in other notes where Aldridge comments on the cognition of the “European Mind” and that of the “Native Mind” where he says the “Javanese is not satisfied to stick to the definite and known.” Aldridge, seems to articulate something inherent in the background knowledge that may be unfamiliar to the “European” and seems to contradict himself with his discussion of speculation, as if an action based on European speculation is of better quality than the act of the Javanese reacting to their environment with knowledge unfamiliar to the European Figure 1.7.

Figure 1.7. Pre-WWII academic perspectives of the “Native” and the Unknown Known

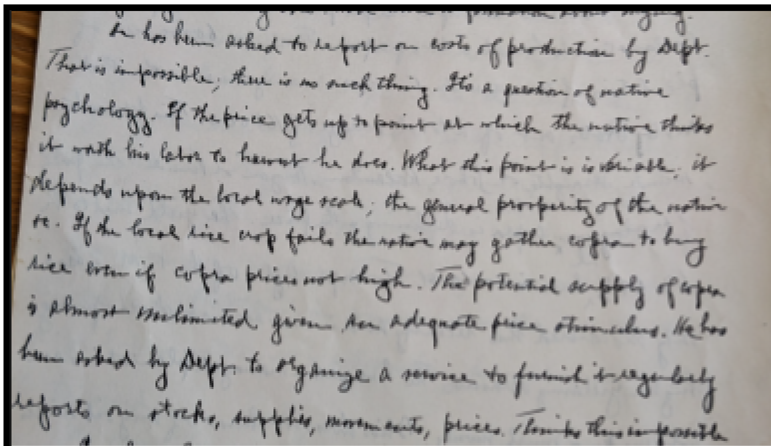

The education of the native is now showing its effects. He is now passing through the phase of adjusting himself to western methods of government. He has as yet a different mentality from that of Westerners. I asked C.M. to specify. He said the Javanese is not satisfied to stick to the definite and known. C.M. drew a diagram . A European mind is investigating & thinking about a matter sticks to the known facts or at most speculates about them. A Javanese is not willing to wait till new facts tender the unknown known.

“A European mind is investigating and thinking about a matter sticks to the known facts or at most speculates about them. A Javanese is not willing to wait till new facts tender the unknown known.”

Aldridge, Field Notes

Perhaps, Aldridge here is framing a sort of precautionary versus adaptive approach to decision that values the precautionary more than the experimentation. Further, paradoxical language is used in his notes in Figure 1.8. to characterize the “Native Psychology” as one that responds to pricing stimulus and real time market and environmental dynamics, such as a local wage rate, as a problematic process for the planned production quotas that are requested by foreign traders. As if the “Natives” interests in localized and free market incentives and adapting to price stimuli with alternative local production including gathering and foraging were a backwards psychology, a lack of willingness to harvest at a rate that is favorable to the global marketplace rather than the “worth of his own labor” is a rather follow a logic of practical decision based on local knowledge of market and resource conditions.

Figure 1.8. A colonial paradox in characterization of "native psychology" as adaptive


he has been asked to report on costs of production by Dept.
That is impossible; there is no such thing. It's a question of native
psychology. If the price gets up to point at which the native thinks
it worth his labor to harvest he does. What this point is is variable. it
depends upon the local wage scale; the general prosperity of the native
etc. If the local rice crop fails the native may gather copra to buy
rice even if copra prices not high. The potential supply of copra
is almost unlimited given an adequate price stimulus. He has
been asked by Dept. to organize a service to furnish irregularly
reports on stocks, supplies, movements, prices. Thinks this impossible

"It's a question of native psychology. If the price gets to the point at which the native thinks it's worth his labor to harvest he does. What this point is is variable. It depends on the local wage scale. If the rice crop fails the native will gather copia."

Karl Aldridge notes on characterization of production costs at large scale for rice export and the adaptive localized labor response.

Source: Stanford Special Collection Karl Aldridge notes founder of the Stanford Food Institute

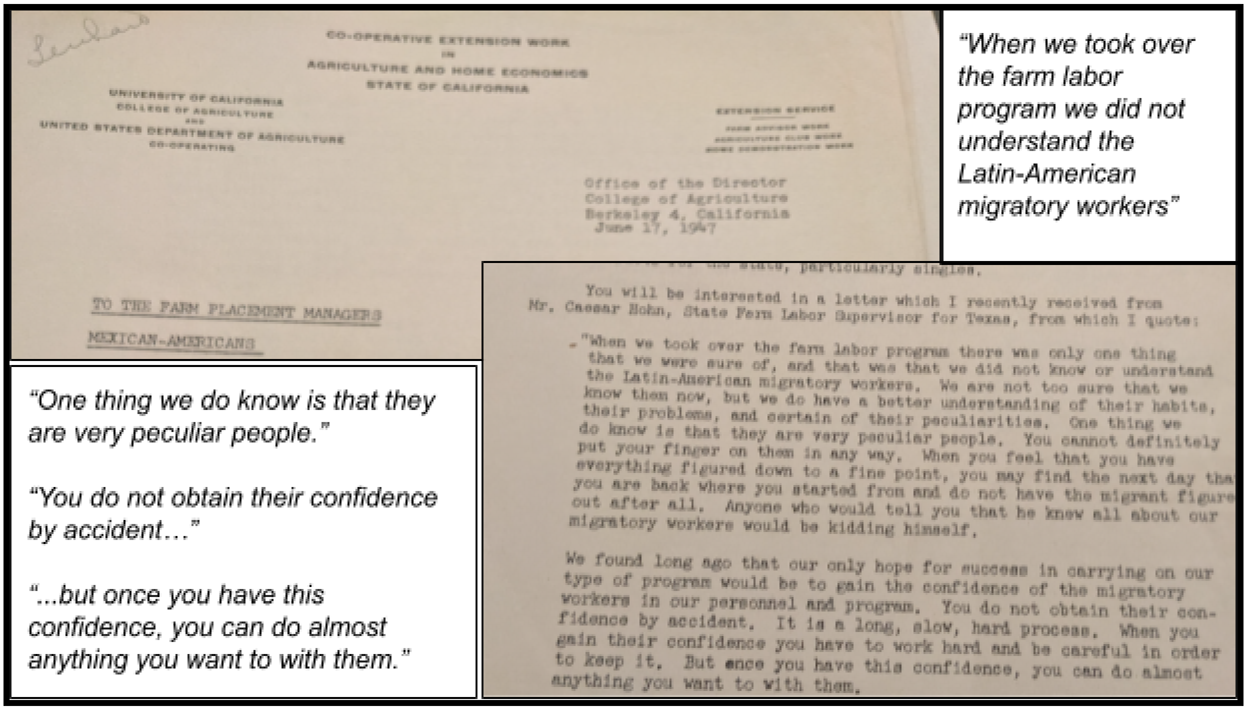
These archived documents established in years predating the WWII Bracero program point to the dependence on a globalized marketplace for food commodities that is not necessarily in the interest of the local producer, cultivator and harvester, but rather works on a planned quota system and set standard wage price setting in a colonial monopolistic labor market. Such institutional non-market price setting seeks to secure pricing and commodities at rates that do not take into account local conditions and more adaptive responses to environmental and social criteria and resource availability.

In contrast, to this colonial logic an excerpt from a 1939 publication "the Seven Pillars of Stock Market Success anonymously published by Seamans and Blake Chicago in the chapter on Truth states, "Whether you will make or lose money in the market depends one hundred percent on what you do at a particular moment." Perhaps, the "native Javanese" had a copy of this book, which outlines a clear logic of market adaptation.

This general approach of extracting product and labor surplus from the land outside of US territory, is later observed in the settlement, resettlement, transport and trading of Bracero bodies and other Central American, Philippinos, POWs and interned Japanese during the World War II era. Such thinking and policy can be observed in the letters, notes of archived records of the representatives of the University of California Extension Service in the College of Agriculture at the University of California Berkeley and the correspondence with Federal and State Administrators of the Bracero and related agencies tasked with Food Security.

The description by UC Extension's office of the director elicits a "peculiar" case of othering and baseless logic as these migrant workers are defined as a "peculiar" race of people that desire trust built over long periods Figure 1.9. The text of this letter written to program farm placement managers in this 1947 correspondence from administrators of the Farm Labor Program at the University of California Berkeley, Cooperative Extension Service and the Department of Agriculture and Home Economics, discusses this illogical exercise for gaining trust of "peculiar people" so that once that confidence is gained "you can do almost anything you want to with them."

Figure 1.9. By U.C. Extension – Gaining confidence with "very peculiar people"?


CO-OPERATIVE EXTENSION WORK
IN
AGRICULTURE AND HOME ECONOMICS
STATE OF CALIFORNIA

UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AND
UNITED STATES DEPARTMENT OF AGRICULTURE
CO-OPERATING

EXTENSION SERVICE

Office of the Director
College of Agriculture
Berkeley 4, California
June 17, 1947

TO THE FARM PLACEMENT MANAGERS
MEXICAN-AMERICANS

... the state, particularly singles.

You will be interested in a letter which I recently received from Mr. Caesar Hohn, State Farm Labor Supervisor for Texas, from which I quote:

"When we took over the farm labor program there was only one thing that we were sure of, and that was that we did not know or understand the Latin-American migratory workers. We are not too sure that we know them now, but we do have a better understanding of their habits, their problems, and certain of their peculiarities. One thing we do know is that they are very peculiar people. You cannot definitely put your finger on them in any way. When you feel that you have everything figured down to a fine point, you may find the next day that you are back where you started from and do not have the migrant figured out after all. Anyone who would tell you that he knew all about our migratory workers would be kidding himself.

We found long ago that our only hope for success in carrying on our type of program would be to gain the confidence of the migratory workers in our personnel and program. You do not obtain their confidence by accident. It is a long, slow, hard process. When you gain their confidence you have to work hard and be careful in order to keep it. But once you have this confidence, you can do almost anything you want to with them.

Source: Raymond Roth Papers, UC Davis Special Collections

The presentation of related primary source archived materials provide evidence of the commodification of the Mexican National and transport and trading of bodies, as agents of the State negotiate increased need for labor inputs in intensive agriculture in California that requires consistent import of labor, use of prisoners and the consistent conflict of non-competitive quota practices that keep domestic labor or "unaccustomed workers" out of the field. The concept of "transported labor" points to basic assumptions used in later chapters as criteria for a labor over land model that addresses the temporal and spatial costs of moving labor time over the landscape and their proximity to long term housing and connection and long term productivity with the land.

1.6 The Fall of Decentralized Decision and the Rise of Catastrophic Fire

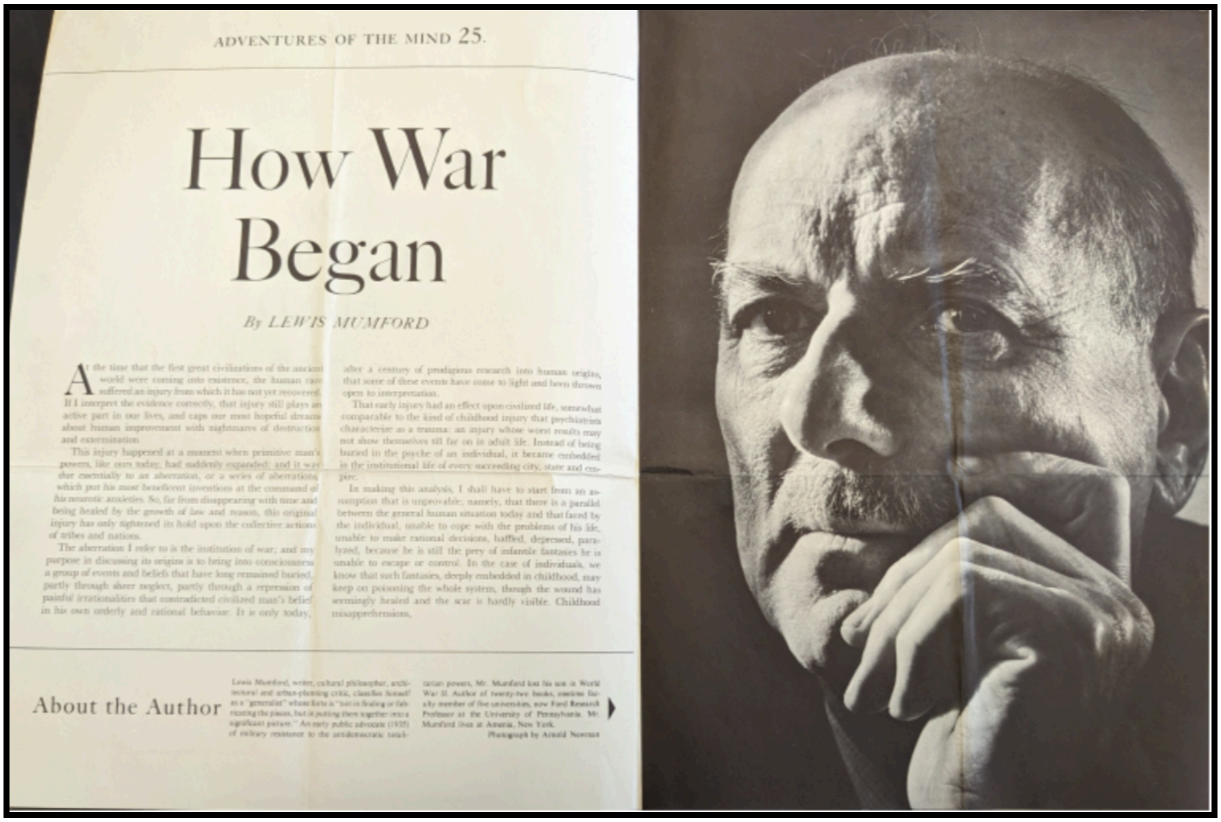
In Carl Sauer's later correspondence with Lewis Mumford in the late fifties, he laments "the future that could have been", but was not. The writings of Lewis Mumford, their correspondence and other contributions follow the development and impact of a different instance of another kind of human caused catastrophic fire at the end of World War II in the Pacific. These dialogues point to decision in an academic psychology with 'deep irrationality', as Mumford puts it in his 1959 message in the Saturday evening Post:

“...without the physical resources of an all-powerful state and the intellectual resources of an all-knowing corps of scientists, that sudden command of cosmic energy and interplanetary space would not have been possible…”

Mumford argues for a recalibration of thinking in centralized planning and decisions in development to open up to a more integrated view of decentralized systems. The article goes further to say that “the greater part of the world’s population, living in rural communities, immune… from the rapacious temptations of urbanized power, constituted a reservoir of vitality and sanity.” That this catastrophic fire power unleashed on Nagasaki and Hiroshima marked an end to “a naivety that human beings could no longer excuse themselves from the powers of the fantasies that governed ancient founders of civilizations,” is a telling rebuke of the central planning and institutional inertia that has caused “a deep irrationality at the very peak of science and technology that first brought it into existence.” His words forebode the consequential decisions that plagued the post-war period, the rise of the cold war and skirmishes and conflicts around the world that have been based on the work of the forced labor that was required to develop “public works - canals, embankments, roads, walls, “pyramids”...either conscripted for part of the year or permanently enslaved.” In the context of the two decades of the Bracero Program and continued guest worker programs to date, low wage farm work continued to underpin this institutional imbalance and a politics based on conflict rather than a politics in practice akin to Mumford’s concepts of self regulation.

In correspondence with Sauer, Lewis Mumford as President of the American Academy of Arts and Science, warned of the false aspirations of the so-called Nuclear or Space Age and rather promotes the values of self-understanding, self-control and self-transcendence, in essence, a process of self-regulation or self-determination that has been lost, Figure 1.10.

Figure 1.10. Mumford's Adventures of the Mind - Saturday Evening Post 1959



ADVENTURES OF THE MIND 25.

How War Began

By LEWIS MUMFORD

At the time that the first great civilizations of the ancient world were coming into existence, the human race suffered an injury from which it has not yet recovered. If I interpret the evidence correctly, that injury still plays an active part in our lives, and caps our most hopeful dreams about human improvement with nightmares of destruction and extermination.

This injury happened at a moment when primitive man's powers, like ours today, had suddenly expanded; and it was due essentially to an aberration, or a series of aberrations, which put his most beneficent inventions at the command of his neurotic anxieties. So, far from disappearing with time and being healed by the growth of law and reason, this original injury has only tightened its hold upon the collective actions of tribes and nations.

The aberration I refer to is the institution of war; and my purpose in discussing its origins is to bring into consciousness a group of events and beliefs that have long remained buried, partly through sheer neglect, partly through a repression of painful irrationalities that contradicted civilized man's belief in his own orderly and rational behavior. It is only today, after a century of prodigious research into human origins, that some of these events have come to light and been thrown open to interpretation.

That early injury had an effect upon civilized life, somewhat comparable to the kind of childhood injury that psychiatrists characterize as a trauma: an injury whose worst results may not show themselves till far on in adult life. Instead of being buried in the psyche of an individual, it became embedded in the institutional life of every succeeding city, state and empire.

In making this analysis, I shall have to start from an assumption that is unprovable; namely, that there is a parallel between the general human situation today and that faced by the individual, unable to cope with the problems of his life, unable to make rational decisions, baffled, depressed, paralyzed, because he is still the prey of infantile fantasies he is unable to escape or control. In the case of individuals, we know that such fantasies, deeply embedded in childhood, may keep on poisoning the whole system, though the wound has seemingly healed and the scar is hardly visible. Childhood misapprehensions,

About the Author

Lewis Mumford, writer, cultural philosopher, architectural and urban-planning critic, classifies himself as a "generalist" whose forte is "not in finding or fabricating the pieces, but in putting them together into a significant picture." An early public advocate (1935) of military resistance to the antidemocratic totalitarian powers, Mr. Mumford lost his son in World War II. Author of twenty-two books, onetime faculty member of five universities, now Ford Research Professor at the University of Pennsylvania. Mr. Mumford lives at Amenia, New York.

Photograph by Arnold Newman

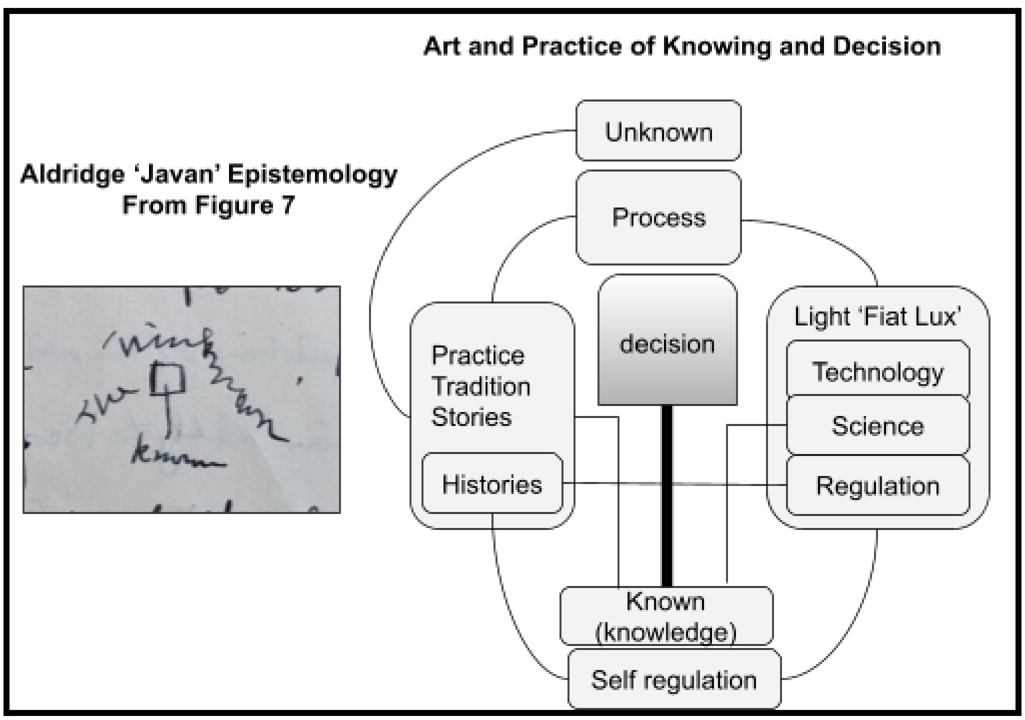
Source: Carl Sauer Papers, Bancroft Special Collections, University of California Berkeley

Such a process of self-regulation that considers the biological mutualisms that he observed in many organisms was foundational in this article and this thinking in his role as a city planner and transdisciplinary academic. An important aspect is the connectivity, the systems of infrastructure and networks that move people, demand labor and provide the direction of development.

This discussion by Mumford of the processes of self-regulation, and hence decision, and the earlier critique of the "native" mindset as being unreasoned or "peculiar" denotes the contradiction between the outside observer or type of observation bias that may miss the whole picture of diverse knowledge systems interacting. As systems theorists and planners who lament the large-scale constructions of the built environment that shifted both processes and living practice, both Mumford and Sauer find the connectivity to the "natural" world an essential quality of a sound mind and life. Both discuss the connection to a rural life filled with not only the local observations of the adventurous scientific mind, but also the "vantage points and slow locomotion" that may be conducive to a more locally connected practice, providing allowable time for the art of storytelling and practiced ways of knowing in the traditions and histories of a particular place.

As opposed to Aldridge's critique of the unreasoned mind of the native Javanese as shown in depictions from his notes in figure 1.7. of what appears to be a lamp of light or light bulb with "the known" cast underneath and the unknown floating above, perhaps we can consider, Figure 1.11. which reframes this image within a theoretical schematic of art and the novel practice of knowing and decision. Rather than falling into contradiction in the notion that Aldridge puts forward that the Western mind relies on decision from fact, we can borrow from Mumfords descriptions of interconnected systems training the mind, to better understand the processes that underpin knowing - that are more entangled in the practice of language, stories and histories than Aldridge may have admitted in his critique of the Javanese worker and their interest in self subsistence and traditional and local adaptive practice.

Figure 1.11. Art and practice of knowing and decision: on adaptation to the unknown



In this figure 1.11, decisions are made as the result of ongoing processes that interact not only in the science of fact based inquiry of what may be known, but also through engagement with traditional practices, and the histories that inform - what could be - or the unknown. In the context of the Bracero experience, both in the removal of the migrant native worker from their origin and the placement into a new technological and regulatory paradigm, this relocation or "moving of mexicans" led to a disruption of the practices and traditions on the landscape and interactions with technological and regulatory processes that interfered with a system of self regulation, local dynamic knowledge and the resulting decisions - leading to the rise of catastrophic fire over time. Such learning loss or the art of knowing is discussed in Carney's work "Black Rice" which frames the knowledge inherent in traditional rice cultivation and the conflict between the knowledge gained through a series of tasks that informs good decisions, while an underclass is not afforded the power for that decision in practice.

1.7. “Moving Mexicans” and disrupted process in tradition and land connection

The movement and transport of the Braceros “by trainloads of Mexicans” (Figure 1.12.), urgently removed, and relocated, embodies a cost of disconnection from the traditional farming practices to a life of migration, urbanism and transformation of the coupled land and labor relationship. This decoupling ushers in a transformation of knowledge and adoption of a “mind of mechanization” in farming that becomes one directional over the subsequent decades as social networks and land stewardship adapts to the missing element of the individual, connected community and a generational transition in knowledge and labor.

Figure 1.12. Moving Mexicans by the Trainloads: An Infrastructure of Extraction

> The State office has been called upon several times to allocate trainloads of Mexicans with only a few hours to work on the problem. It is essential that the State office be kept currently informed as to the needs in the counties, and that the county staff be currently informed as to the opinions of county farm

Source: Farm Labor Letter #119, College of Agriculture, Berkeley 4, California June 16, 1944 From UC Davis Special Collections, Raymond Roth Papers Box #4

This transformation begins prior to World War I, coincident with the history of extraction by railroad extension, timber, mining and trade in commodities in the 19th century, along with trade in goods dating to the periods of European conquest, but a letter from a farm placement agent Hayes in the Raymond Roth collection, highlights the contribution of this labor force beginning in World War I and World War II and “again helping to maintain production during the Korean emergency.” Hayes states, “not only has the Mexican Farm worker enabled California to maintain and augment its production of food, feed, and fiber, but also the workers have contributed to a strong and friendly neighbor to Mexico.”

In another Statement made by H.R. Wellman, Vice President of Agricultural Sciences at the University of California on May 10, 1954 at the Meeting of the State Board of Agriculture in Mariposa, Wellman refers to the historic California Gold Rush as “The Farm Rush” where he compares the population and farm production of the time of the Gold Rush induced food shortage and the scramble to ensure the provisioning of the 58,000 miners in the State in 1950 with the 1,500 farmers at that time, along with imports and cattle driven from Mexico and Texas. (Raymond Roth Papers , D234, Box 3.) Wellman states that the future of California agriculture is bright, provided only that we and our successors retain the same high spirit of adventure, of self-reliance, of independence, and of enterprises which characterized the early pioneers…and states the growth and encroachment of cities on good agricultural land has not hindered the rapid growth of agriculture and irrigated acreage. He discusses the shift in the late

1880s from cattle and wool production to more labor intensive crops like fruit and vegetables to meet rising domestic and global demands for dried fruits.

These labor intensive industries required a steady stream of new migrants, laborers that could be moved around based on seasonal crop prioritization, global commodity prices and any request for farm labor with the only downside to growers a potential “shortage of Mexicans,” at harvest time. Figure 1.13 below demonstrates the contradiction of time and crop prioritization, as time is money and labor is cheap as long as no “shortage of Mexicans” exists, “whose responsibility” it is to indicate relative importance for harvesting demonstrated that within this quota-based planned agricultural labor supply. Crocheron’s letter seems to be asking for Adam Smith’s freehand to name its interlocutor. The lead time to the certification of need appears to be an attempt to lock in a planned allocation of contract labor, yet the uncertainty faced by farmers and potential market demand may provide a more “urgent need” to “move mexicans" elsewhere without any market exposed variability in the price of labor.

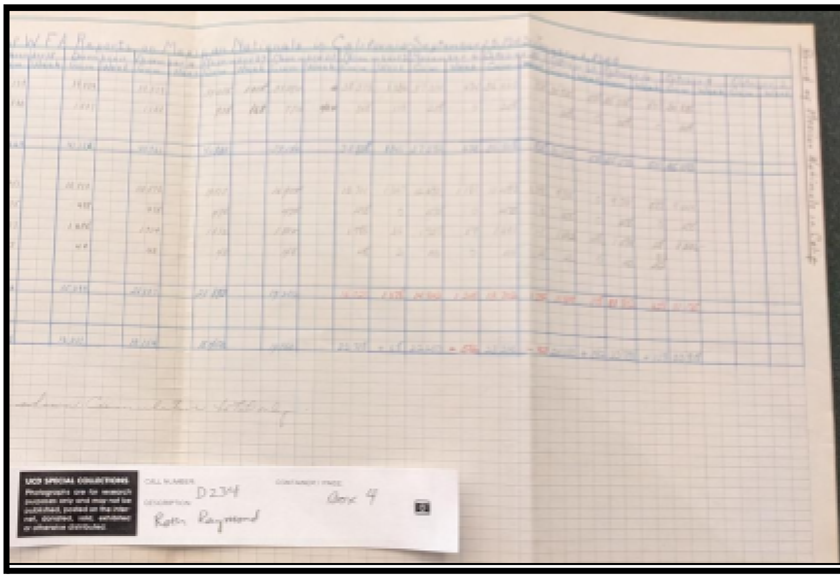
Prior to World War II the economics theory and research that was referenced by the Farm Security administration included consideration of the policies that would support the development of rural resources and consider the support for family farms and small holders that were identified as a crucial and important focus of the mission of the Farm Security Administration.

> *“California produces many crops in common with Mexico. The development of agriculture has been accompanied by considerable experimental research and great progress in farming methods, crop yields, and mechanization. The participation of Mexican workers in California farming has enabled them to gain first-hand knowledge of these improvements and experience which has aided them in applying the methods to the improvement of their own farms upon return to Mexico…Others have their savings to enter non-agricultural occupations [upon their return to Mexico].*

The Letter highlights the program’s benefit of the “constructive expression of neighborliness between the two countries.” Edward F. Hayes, Chief of Farm Placement, California State Department of Employment, Affiliated with the U.S. Department of Labor, September 8, 1952. Raymond Roth Papers, Call#D234, Box 3 UCD Special Collections. Accessed February 2023.

The rationale for the program as a technology transfer program and the accumulation of operational knowledge that would be transferred and implemented across borders stands in contradiction to the alternative outcome highlighted from the Hayes letter and following statistics which points to the specific impact associated with the migration and de facto removal of this rural labor from the Mexican countryside to the Urban North American Landscape as train loads of Mexicans arrived with some missing, deceased or otherwise unaccounted for. Figure 1.13. Shows an accounting from 1943 and 1944 of the monthly tally of Bracero bodies with cumulative totals as of January 1, 1944 of the arrival of 39,834 Mexican Nationals with roughly 65% of those returning as repatriated within the year and another almost 5% either missing or deceased. As the programs continued the numbers of imported labor, missing and deceased continued to rise.

Figure 1.13. “Moving Mexicans” and accounting for Bracero bodies



First Year Braceros
1944 data table of total Mexican Nationals in California by month showing cumulative totals of arrivals from origin, repatriated, missing and deceased.

Jan 1,1944 stats

Arrived from origin	39,834
Repatriated	26,738
Missing	1714
Deceased	54

Source: Summary of WFA Reports on Mexican Nationals in California, September 25, 1943, Raymond Roth Papers.

The agreement between the California department of Labor and the U.S. Department of Labor included a balancing act by the California administration to “NOT authorize Mexican labor to meet shortages in areas where domestic labor is deemed not sufficiently available If the employment of Mexican labor would adversely affect the wages or working conditions of domestic workers similarly employed.”

The question of “adverse effects,” stated in the federal statute that forms the Treaty of labor agreement of this program is problematic both in the interpretation of “adverse effects” and the consideration for resolving the issues that have arisen from the Mexican National labor program that “has worked to the disadvantage and detriment of domestic workers”. Particularly in the case of foreign labor driving down wages for domestic labor as highlighted in a speech given by D.H. Romey to the Farm Bureau. (D.H Romey Speech to Farm Bureau, Speech from the California Department of Employment given California Farm Placement A Service to Growers. Raymond Roth, D234, Box 3.) In the speech, the challenge and obligation to consider and balance the impacts to both growers, the productivity of California agriculture and the adherence to the provisions in the Statute and International treaty are emphasized. The long term effect of this disconnection and imbalance is stated by other agents in the field as well.

Farm placement manager John Zuckerman stated:

> *our migrants today, excluding the foreign contract workers, are for the most part, the least talented, least capable, least employable members of our society, these people are driven to migrant work because you and your fellow citizens in the communities in which you reside have not permitted them to be educated and motivated to become an integral part of the permanent industrial or agricultural work force. You – or perhaps I should say we – have not taken the necessary action, even where education and motivation prevail, to provide gainful, vocational opportunities that will permit these people to sink their roots in the community of their choice realize the ideal and goal of every American – a permanent home, a place in the community for themselves and their family.*

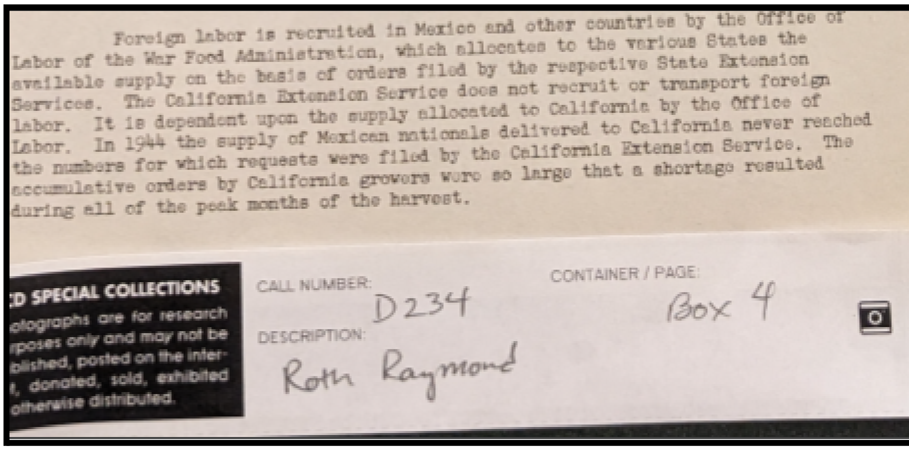
Figure 1.14. Shows a well known image from the Raymond Roth Papers showing a "rootless" child traveling likely with a parent as a transported worker following the Bracero program.

Figure 1.14. The Rootlessness of Moving Mexicans and the impermanence of the transported worker

Source: From Raymond Roth Papers, University of California, Davis Special Collections

However, regardless if some would choose to return as a transported worker year after year, the below comments and excerpts from a Farm Security Administration Conference speech by John Zuckerman in the post war era appear to foretell an unlimited supply over the long run. Continuation of the Bracero Program and subsequent guest worker programs extended into decades during times of overseas conflicts resulting in increased immigration to California and additional sources of farm and industrial labor in the following years from refugees and outmigration from the Korean conflict, Vietnam war and other regions of American involvement or other global conflicts as Zuckerman points to "replenishing the supply… (by) … relying on misfortune abroad." Yet in the context of Interstate migrations , while UC Extension was required to take orders and manage foreign labor once it crossed the border, the recruitment of this supply was managed by federal authorities and UC extension officials acted as price setters managing the quotas, and demand and to some extent through setting administration guidelines in the program, the supply of California labor Figure 1.15.

Figure 1.15. Mexico, an inexhaustible source of Foreign Labor with limits to recruitment?



Foreign labor is recruited in Mexico and other countries by the Office of Labor of the War Food Administration, which allocates to the various States the available supply on the basis of orders filed by the respective State Extension Services. The California Extension Service does not recruit or transport foreign labor. It is dependent upon the supply allocated to California by the Office of Labor. In 1944 the supply of Mexican nationals delivered to California never reached the numbers for which requests were filed by the California Extension Service. The accumulative orders by California growers were so large that a shortage resulted during all of the peak months of the harvest.

D SPECIAL COLLECTIONS
ographs are for research rposes only and may not be blished, posted on the inter- t, donated, sold, exhibited otherwise distributed.
CALL NUMBER: D234
CONTAINER / PAGE: Box 4
DESCRIPTION: Roth Raymond

Foreign labor is recruited in Mexico and other countries by the Office of Labor. The California Extension does not recruit or transport foreign labor.

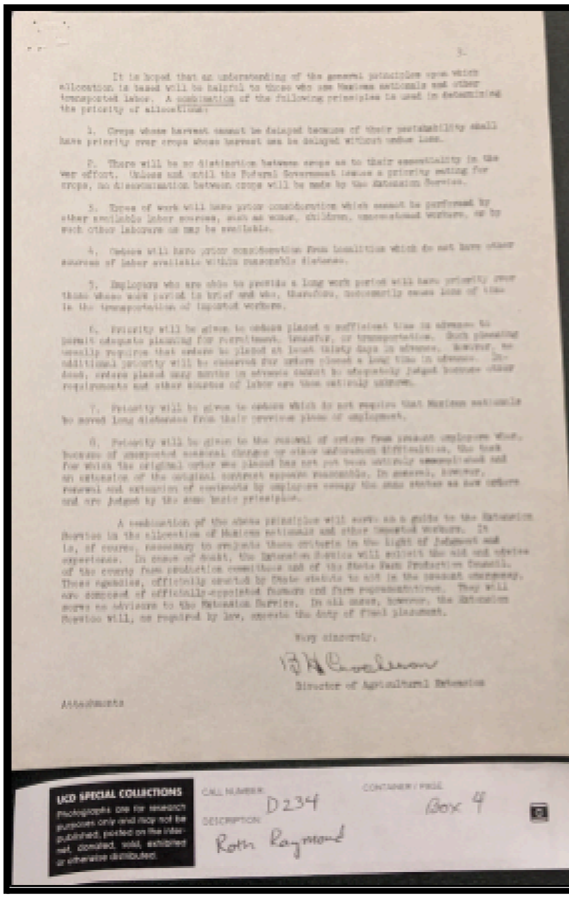
Zuckerman in his address states that the denial of these rights leads to destitution and desertion and abandonment and eventually “you often become bitter and recriminatory and militant.” And he questions whether there is a real desire to help the migrant or is this an aggression born out of your own sense of guilt…” 1951 “the report of the President’s Commission on Migratory Labor”, March 1951 before Public Law 78 was codified.

> *…migrants are children of misfortune. They are the rejects of those sectors of agriculture and of other industries undergoing change. We depend on misfortune to build up our force of migratory workers and when the supply is low because there is not enough misfortune at home, we rely on misfortune abroad to replenish the supply…*
> *(John Zuckerman, Raymond Roth Papers, UC Davis)*

These comments were made on the impact of Public Law 78 On Migrant Labor presented Before The National Conference To Stabilize Migrant Labor November 21-22, 1959. The statement references the European influx after 1917, laws for farm labor and the prior dependence on permanent flows of “labor force in the Chinese, Japanese, and Hindus.”

These points made by Zuckerman underpin the importance of the modes of transportation and the recruitment from the location of origin as an important marker in identifying the pull and push factors in consideration of the work opportunity. These removals experience a yearlong accrual of effects and costs in the local geography of origin, when the long-term economic prospects and tradeoffs are not presented at the onset. Key considerations for the temporal and spatial costs and scale of addressing challenges of intensive farming, particularly without a steady local labor availability, are highlighted in this communication in 1945 by UC Extension.Figure 1.16

Figure 1.16. The "Unaccustomed Worker," Transported Labor, "Reasonable Distance"and No Crop Discrimination as Principles of Extension Service



UC Agriculture extension Correspondence Circa 1945

Guidance on priorities in placement with time and transport constraints to those who "use mexican workers and other transported labor"

3. Types of work will have prior consideration which cannot be performed by labor sources such as women, children, "unaccustomed workers," or by such other laborers as may be available.

4. Orders will have prior consideration from localities which do not have other sources of labor available within reasonable distance.

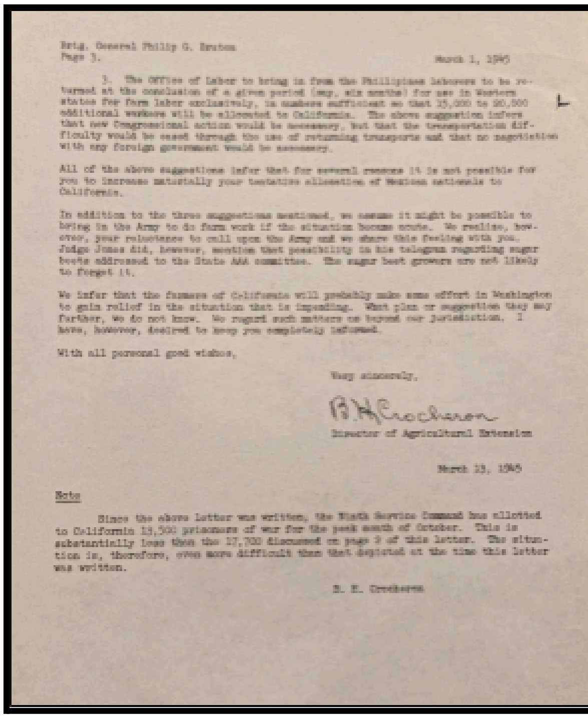
Priority given to orders without "Necessarily cause loss of time in the transportation of workers"

Source: Raymond Roth Papers, UC Davis Special Collections Box 4.

What was sold as a short term annual or wartime program created a slippery slope to the extension of the program to include new arrivals and a constant shifting and switching of employers and non competitive contract labor. This scenario exists for most contract labor systems that neither provide the requisite housing and community accommodations, or path to long term residence, but rather provide a flexible housing and consumption pattern that may benefit the farm or property owner at the expense of the contract worker who is required to purchase daily necessities, entertainment and other services such as medicine and laundry from the property owner that has a monopoly on the provisioning of materials to serve this captured market.

Dependence on these quota systems of procured labor and the lack of opportunities of workers to develop additional side businesses, grow crops for daily consumption contributed to the type of homogenous cropping systems with high chemical inputs and costs scaled to incentivize global growth in commodities markets. Such structured trade and labor deals, including monopolies in logistics and shipping favored single contracts and suppliers over competitive markets. The consideration of these alternate scenarios began with the Food security administration's economic analysis and the earlier academic perspectives discussed prior to establishment of the war. As years passed the additional requests for use of prisoners of war, Central American labor and Philippine labor reinforced the non-market wage that would lead to a longer term domestic workforce with an unfair wage, these considerations are highlighted in the points raised in Figure 1.17 in a letter from UC agricultural extension Director to Brig. General Bruton on the trading of Mexican labor, for POWs, Central Americans and Philippine transported labor by use of military transport and command control measures.

Figure 1.17. Trading off Mexicans, POWs, Central Americans and Philippine labor



Brig. General Philip G. Bruton
Page 3.

March 1, 1945

3. The Office of Labor to bring in from the Philippines laborers to be returned at the conclusion of a given period (say, six months) for use in Western states for farm labor exclusively, in numbers sufficient so that 15,000 to 20,000 additional workers will be allocated to California. The above suggestion infers that new Congressional action would be necessary, but that the transportation difficulty would be eased through the use of returning transports and that no negotiation with any foreign government would be necessary.

All of the above suggestions infer that for several reasons it is not possible for you to increase materially your tentative allocation of Mexican nationals to California.

In addition to the three suggestions mentioned, we assume it might be possible to bring in the Army to do farm work if the situation became acute. We realize, however, your reluctance to call upon the Army and we share this feeling with you. Judge Jones did, however, mention that possibility in his telegram regarding sugar beets addressed to the State AAA committee. The sugar beet growers are not likely to forget it.

We infer that the farmers of California will probably make some effort in Washington to gain relief in the situation that is impending. What plan or suggestion they may further, we do not know. We regard such matters as beyond our jurisdiction. I have, however, desired to keep you completely informed.

With all personal good wishes,

Very sincerely,

B. H. Crocheron
Director of Agricultural Extension

March 13, 1945

Note

Since the above letter was written, the Ninth Service Command has allotted to California 13,500 prisoners of war for the peak month of October. This is substantially less than the 17,700 discussed on page 2 of this letter. The situation is, therefore, even more difficult than that depicted at the time this letter was written.

B. H. Crocheron

Correspondence between UC Director of Agriculture and Brig. General Bruton (1945)

More Mexicans? Returnable Philippine workers and allocation of prisoners of war for farmwork.

- *Office of labor to bring in Phillipine laborers to be returned after a period of farm labor. 15,000 to 20,000 to relocated to California. To meet a shortfall in Mexicans*
- *Transportation difficulties can be alleviated by military transport.*
- *Potential for army to do farm labor as needed.*
- *Allotment of 13,500 prisoners of war allocated by the ninth service command to help with October harvest.*

The comparison across these options of low wage or coerced labor as in transported or prison labor are brought to light in this correspondence with Brig General Bruton comparing the effectiveness of Mexican, Native American, and Prisoner of War effectiveness in field work. Here UC extension clearly discusses the challenge of housing all the migrant farm labor and makes the statement that due to the inability to get more productivity out of prisoners of war as they only compare to 60% of the efficiency of a Mexican National, therefore the housing accommodation would be better spent on Mexican or a Native American workforce, Figure 1.18.

Figure 1.18. Sixty percent efficiency - A ranking of the POW, Mexican and "Native American" in competition for housing

Brig. General Philip G. Bruton
Page 2.
March 1, 1945

It is evident that no matter how we distribute this small number that are forthcoming, it will be impossible to supply the probable needs of the state.

As we have written you, in reply to your wire of February 27, we have notified the Ninth Service Command of our estimate of need of prisoners-of-war in varying numbers from 7,600 in February to a high of 26,500 in October. However, we have housing in sight for only approximately 17,700. Furthermore, the Army has not been successful in getting from prisoners an average accomplishment in California of more than 60% of the amount of work done by a Mexican national. The 17,700 prisoners for whom we have housing could be considered therefore as only the equivalent of 10,620 Mexicans. Even if the Army gives us the entire allotment of 17,700 prisoners for whom we have housing available, these, added to the 13,000 Mexicans in your tentative allotment would still leave a prospective shortage of 28,380 (if we use the farmers' estimates), or of 10,380 (if we use our own). In either case, there appears to be a material shortage.

The above estimates assume that there will be approximately the same number of native American itinerant workers available in 1945 as in 1944. These native American workers comprise by far the largest segment of the work force. Usually, in most months, they constitute seven-eights of the farm workers. Therefore, even a comparatively small percentage increase in these native American workers might wipe out the prospective deficit. However, it does not appear there will be any such increase. Indeed, my own judgment is that there will be fewer American farm workers in 1945 than in 1944.

Correspondence with Brig. General Bruton from UC extension, 1945

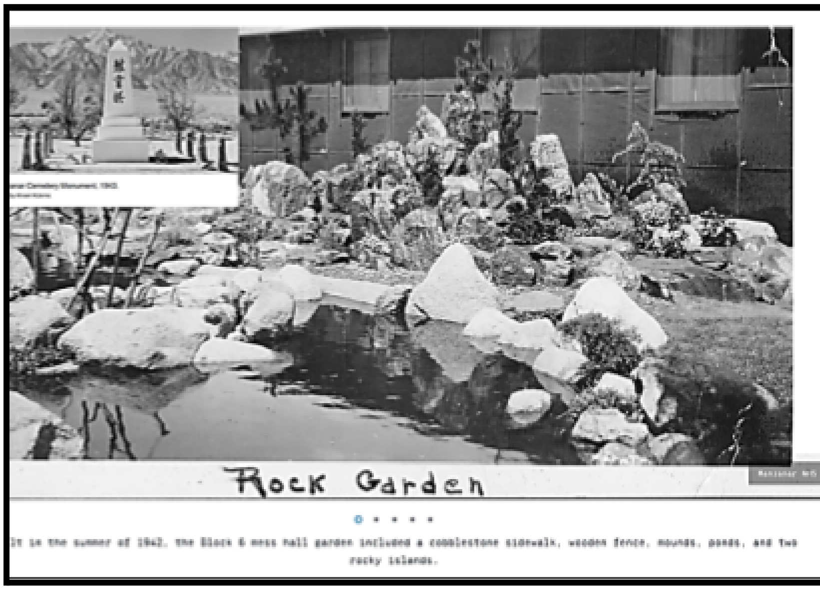
…the ninth service command notified of the need of prisoners of war from 7,600 in February to 26,500 in October. Housing only for 17,700… The army has not been successful in getting from prisoners of war more than 60% of the amount of work done by a Mexican national. The housing for 17,700 prisoners of war for whom we have housing could be considered as only the equivalent of 10,620 Mexicans. The above estimates assume that there will be approximately the same number of native American itinerant workers available in 1945 as 1944. These Native American workers comprise by far the largest segment of the workforce. Usually, in most months they constitute seven-eights of the farm workers. Therefore, even a comparatively small percentage increase in these native American workers might wipe out the perspective deficit.

Source: Raymond Roth Papers, UC Davis Special Collections D234

As the intensification of California farming increased in line with commodity crops the insatiable labor demand sought out broader geographies for such labor exploitation of transported labor. Figure 1.20. furher demonstrates the later shift to considering expanding programs to more Central American Nationals which is in line with the original comments Sauer provided to the federal government on labor surpluses in Latin America prior to the war.

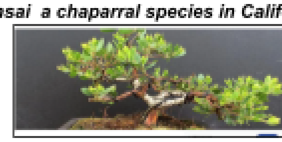
These comparisons across ethnic groups call into question the different knowledge systems and techniques and priorities in the intense agricultural methods of the day. The link between people and plants and different techniques and traditions of cultivation are distinct and at best overlooked here, yet there are also the questions of morale, treatment and conditions of work and housing that have an impact here. While the "movement of Mexicans" and other transported labor has its own stories of coercion, improper treatment and discrimination, that of the Prisoners of war and how they were classified tells a different story. While the Japanese internment caused massive upheaval and loss of property and ways of life for multiple generations of Japanese Americans, these prisoners were relocated and used as labor in desolate areas of California (Azuma,2005). Figure 1.19 shows images of the garden at Manzanar, one of the first internment camps coincident with the rise of the Bracero program.

Figure 1.19. The traditions of people and plants in landscape design as "Prisoners of War"



Reflection from a POW
One Topaz (one of ten camps) resident, Mr. I. Ishii, was an expert in dwarfing trees. He especially missed a thirty-five-year-old maple which he had developed from a seed and had been compelled to leave behind; it was a perfect tree, and was most beautiful in autumn when the foliage turned to gold and yellow. There was too much sun in the desert for dwarfed trees, but he began experimenting with desert plants and soon found that the common greasewood responded satisfactorily. At the time of relocation in 1945, a greasewood shrub (a common name for chamise and other chaparral species) had been coaxed along for two years into a very attractive form. (Baran, 2022)"

Contemporary example of a Manzanita Bonsai a chaparral species in California



Source:doi:10.1103/physrevlett.107.258101. (Left) Website screenshot taken on October 24, 2023.
https://www.reddit.com/r/Bonsai/comments/3amv4b/manzanita_bonsai/

Bonsai and related East Asian traditions introduced by Japanese Americans and others to California have been practiced across the State since the arrival of these migrants in the 19th century. Many of these traditions have been continuous and linked to California Agricultural histories. During the forced internment of Japanese Americans during World War II, these traditions were maintained as a connection to the beauty of natural landscapes, while families were detained, displaced from their farms, and placed under the harshest of conditions as prisoners of war. The image of the Manzanar rock garden built in 1942 (Figure 19, right), in the arid environment of Owen's valley and the hundreds of other gardens created at the time is testament to the historic interconnection of people and plants on California's landscape. An estimated 100 gardens existed at the California Owens Valley site, building between the rows of barracks, mess halls and firebreaks. Manzanar, established in the Spring of 1942, was the first of ten concentration camps imprisoning Japanese-Americans. By July 1942, the population of the camp at Manzanar neared 10,000 with over 90% coming from the areas surrounding Los Angeles, Stockton, and other agricultural regions. Of the population of families including children incarcerated at these camps, buddhist priests and bonsai teachers were also incarcerated there, including at Manzanar, Sam Nakano, Frank Masao Okamura and Chiyokichi Takahashi (Baran, 2022)

The Bracero program in some regard was necessary to fill the gaps created by the Japanese American internment of many agricultural producers that were now incarcerated. The image of the garden and an example of a chaparral species of Manzanita as a contemporary demonstration of Bonsai evokes an image of the interconnected art of plant pruning and cultivation that in some form required human care since California's native population stewarded the landscapes. As the increase of transported or returnable labor continued, the long term stewardship and location based care was repetitively disrupted both at the point of origin and at the point of relocation. The decisions of temporary housing and impermanence and disrupted interconnectedness of plants and people continued and expanded across new borders, Figure 1.20..

Figure 1.20. Returnable Workers and Temporary needs? And the Army of Housing Starts

In order to meet the above probable situation three suggestions have been made as follows:

1. The Army to increase the numbers of prisoners of war available for farm work beyond the numbers presently indicated by the California Extension Service and beyond the number for whom housing is available. To do so would require that the Army should create in California sufficient housing for the increased numbers beyond our estimates.

2. The Office of Labor to bring into the United States laborers from various Central American countries so that the tentative allotment to California may be increased by 15,000 to 20,000 additional imported workers.

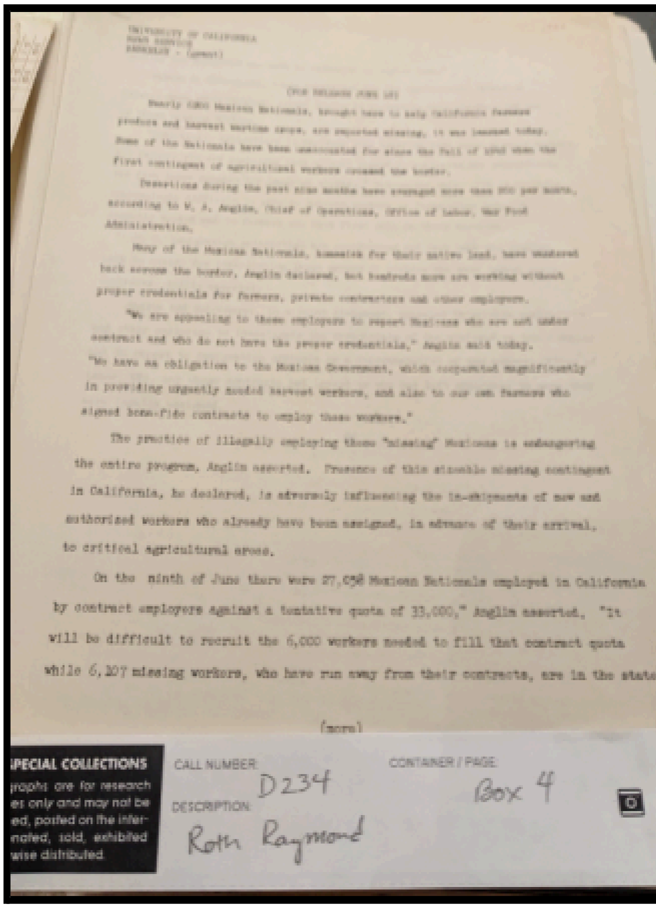
UC Extension Correspondence, 1945

…the army to increase the numbers of prisoners of war available for farm work beyond the numbers presently indicated by the California Extension Service and beyond the number for whom housing is available. To do so would require that the army create in California sufficient housing…the office of labor to bring into the United States laborers from various Central American countries…

Raymond Roth Papers, UC Davis Special Collections D234

As the conditions of transported labor worsened to conditions where Mexican nationals were overworked and underpaid as were several accounts in the Bracero Archive oral histories the number of run away workers increased and led to common challenges still witnessed today in the competition of day laborers and local farm labor competition (Rothenberg, 1998) that increased downward pressure on wages which was a continual struggle between labor activist in subsequent decades. Figure 1.21. identifies the over 6,000 missing Braceros who either left contracts due to unfair working conditions or chose to return to their native lands due to homesickness or need to connect with family in Mexico. These numbers were witnessed in the thousands in the later years of the Bracero program as identified in this University of California correspondence of 1945.

Figure 1.21. Run away "Missing Mexicans" on the eve of Juneteenth 1945



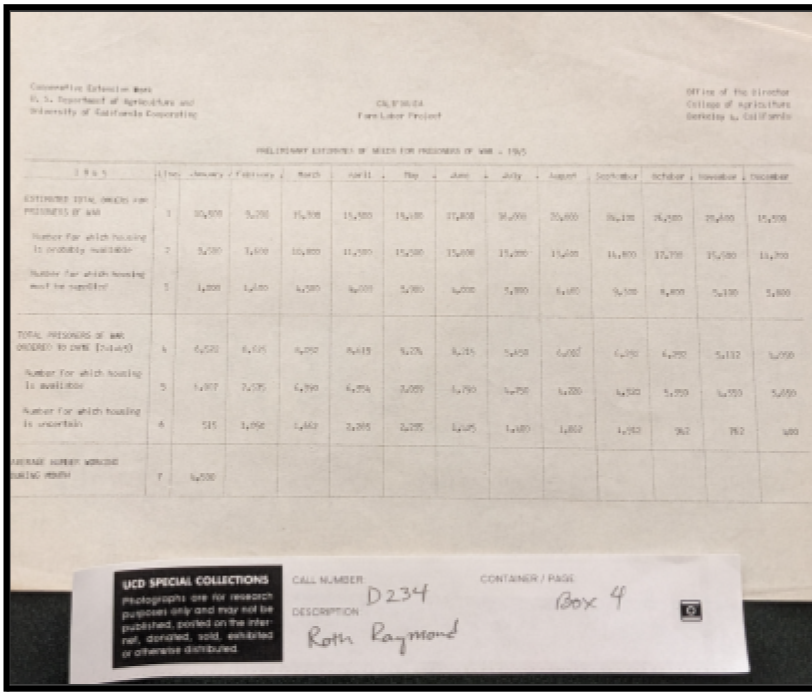
University of California News Service
Berkeley
(for release June 18)

- *Nearly 6,200 Mexican Nationals brought here to help California farmers are reported missing.*
- *Some have been unaccounted for since 1942*
- *Desertions have averaged more than 200 per month.*
- *Many Mexican Nationals homesick for their native lands.*
- *It will be difficult to recruit the 6,000 workers needed to fill that contract quota while 6,107 missing workers have run away from their contracts…*

Source: Raymond Roth Papers, UC Davis Special Collections D234, Box 4.

As the number of missing workers increased renewed calls to meet the shortfalls and replace workers with Prisoners of War continued as the beginning of a cyclical dynamic of apprehensions, unfair treatment and lost opportunities coincided with the rise of prison labor which to some extent continues to this day as was earlier discussed in the Press Democrat article on California Law makers putting forward legislation to end the use of forced labor in agriculture including fighting forest fires. Figure 1.22 points to the constant dilemma of State agents in appropriating either imported labor or prison labor on the land.

Figure 1.22. The Bracero Program in early formulation and the “Wetback Problem”



Cooperative Extension Work
U.S. Department of Agriculture
and University of California
Cooperating on report of Prisoners of War allocation for farm labor as part of California Farm Labor Project.

University of California
College of Agriculture
Berkeley, California

Reports data showing Estimates of Needs and orders for Prisoners of War - 1945

Monthly estimates for 1945 show a high of orders for prison labor as 26,500 for October and a low of 10,500 for January demonstrating a seasonal variation in orders for POWs amid inadequate housing constraints

Source: Raymond Roth Papers, UC Davis Special Collections D234, Box 4.

These conditions continued and led to the identification of “the Wetback” problem with sharply increasing numbers for the next ten years with a total identified by the University of California of an estimated 1,500,000 border crossing apprehensions in 1954 as reported by the immigration and naturalization service IANS, Figure 1.23. As conditions became more challenging in the Bracero program and the back and forth migration led to avoidance of “legal” crossings and other contract work. Migrants became dependent on the constant crossing to provide for livelihoods as they may have faced continuous displacement from traditional networks and land rights at origin.

Figure 1.23. Rise of the Wetback Problem" and the "many times" displaced worker

THE "WETBACK PROBLEM"

(1) Extent of the Problem in Terms of Statistics

a. There has been a continuing and threatening increase in the number of "illegal entrants" from Mexico into the United States during the past decade. Prior to 1944, the number of apprehensions of such entrants was approximately 10,000 a year. The figures for the ten years from 1944 on show the trend as measured in apprehensions reported by the I&NS.

1944	- 50,000	1950	- 575,000
1945	- 75,000	1951	- 736,000
1946	- 100,000	1952	- INA
1947	- 200,000	1953	- 1,000,000
1948	- 210,000	1954	- 1,500,000 (Est.)
1949	- 300,000		

It is not possible to break down the figures on apprehensions into number of individuals involved, as, frequently, individual "illegals" are apprehended many times during a year.

Source: Raymond Roth Papers, UC Davis Special Collections D234, Box 4.

Of key consideration to the administrators of these migrant worker programs was the need for housing and "adequate transportation" with the movement of workers across geographic, occupational and industrial lines. As labor mobility was determined as a top priority by the officials, "necessary migrations" crossed significant geographic, occupational and industrial distance. At each step of the way the conflicts arising from the critical question of building a local permanent work force and providing policies in line with fostering a long term local workforce were constantly in question, yet as pointed out in the Employment security manual the interpretation of "practicable local sources" remains in contradiction with the decades of dependence on transportable labor in these geographies, Figure 1.24.

Figure 1.24. The Practicality of the Employment Security Manual: Practical for whom?

EMPLOYMENT SECURITY MANUAL

Part I — MTL 389

0001-0999 — Organization and General Administration — 0623

Objectives, Regulations, Standards, and Policies — R-10/15/54

*0623 Clearance. IT IS THE POLICY OF THE UNITED STATES EMPLOYMENT SERVICE:

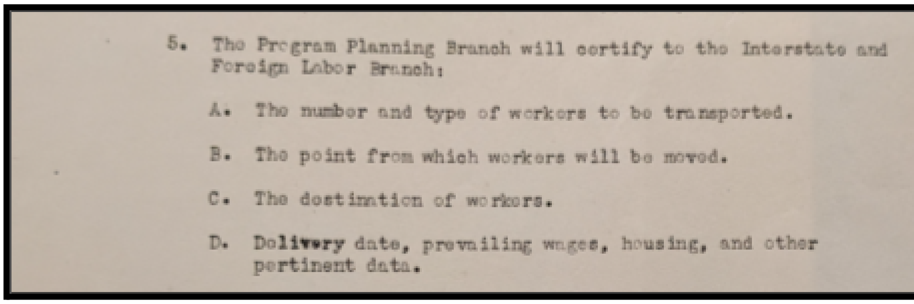
A. To facilitate the mobility of labor by encouraging and guiding necessary migration of workers between geographical areas, and necessary shifts of workers across occupational and industrial lines.

B. To recruit qualified workers from all practicable local sources before resorting to clearance.

Source: Raymond Roth Papers, UC Davis Special Collections D234

These historical considerations of movement of bodies across various boundaries and geographical space and the histories of the evolution of the scale of the problem and associated tradeoffs documented in these primary sources in this Chapter point to some critical assumptions that are as relevant today in the process of “Internalizing Fire” at what cost and scale. Figure 1.25. In the correspondence of the Program Planning Branch found in the Raymond Roth archive identifies key variables discussed in the next Chapters related to landscape management in the context of the availability of number of people performing labor and associated type of labor, the point of origin of transit for work, the potential destination of those workers and associated costs such as time of delivery, housing proximity and other costs.

Figure 1.25. Bracero program planning informing a contemporary “Labor over Land” Model



5. The Program Planning Branch will certify to the Interstate and Foreign Labor Branch:

A. The number and type of workers to be transported.

B. The point from which workers will be moved.

C. The destination of workers.

D. Delivery date, prevailing wages, housing, and other pertinent data.

A 1945 Planners request for a Labor over Land Model

A. Number and type
B. Point of origin
C. Point of destination
D. Housing and wage

Source: Raymond Roth Papers, UC Davis Special Collections D234, Box 4.

1.8 Tracing the Ecological Signals of Good Fire, Out-migration and Suppression

> *"The Physician must be able to tell the antecedents, know the present, and foretell the future – must mediate these things, and have two special objects in view with regard to diseases, mainly, to do good or to do no harm"*
>
> *.HIPPOCRATES, of the epidemics, 400 B.C.E*
>
> *"...None but ourselves can free our minds…Have no fear for atomic energy, cause none of them can stop the time. How long shall they kill our profits while we stand aside and look. Some say it's just a part of it, we got to fulfill the book."*
>
> *Bob Marley, Redemption Song. 1980*
>
> *"My choice is what I choose to do. And if I am causing no harm it shouldn't bother you. Your choice is who you choose to be and if you are causing no harm you are alright with me. If you don't like my fire then don't come around…"*
>
> *Ben Harper, Burn one Down, 1995*

This Bracero labor migration policy as an initial and important component in the decoupling of traditional human fire interactions in the place of origination of these labor migrations at varying degrees, and at a time when more intensive technological and agricultural practices were prioritized in a planned process of human labor removals and technology transfer, had far reaching effects to the cycle of fire at origination and destination (Mazoyer, 2006, Martinez-Matsuda, 2020, Pyne 2016). Additionally, the continuity of related policies and human migrations over subsequent decades have compounded this ecological risk and have created a challenge for contemporary institutional actors that must address both local and global implications simultaneously in a climate policy that works (Cullenward and Victor, 2021).

The estimation of costs, origin and destination in the application of labor and associated process of internalizing fire requires at its base, a localized analysis that integrates historical, ecological and localized food security objectives amid evolving global complex systems challenges. Based on the below data in an adapted figure (Fule et al. 2021) the Bracero period coincides with an overall reduction of fires, fire scars and sites recording fires with significant shifts at the period in the early 20th century during both World War I and World War II when the Bracero program and precedent programs began, Figure 1.26. With likely variation in localized impacts based on land use and vegetation type over this Bracero and later guest worker programs.

Figure 1.26. Sites recording fires and number of Fire Scarred Sites

December 2021 INVITED FEATURE: CLIMATE CHANGE AND WESTERN WILDFIRES Article e02431; page 3

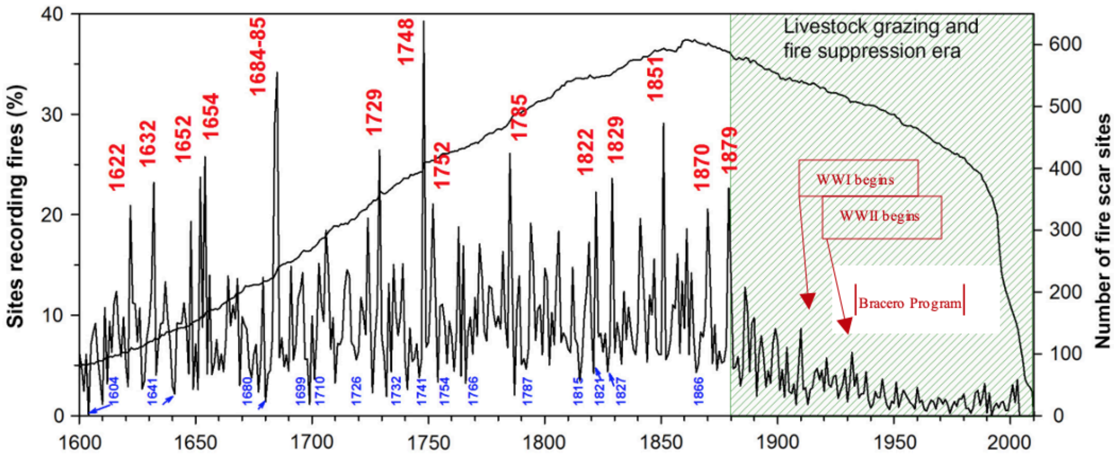


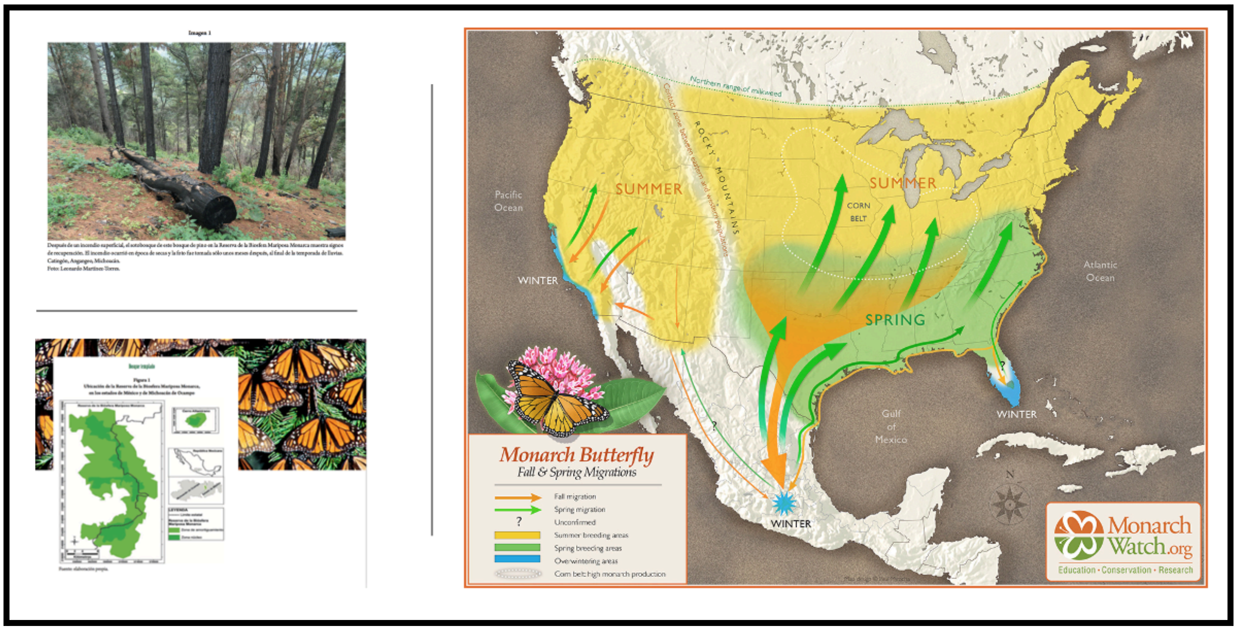
FIG. 1. Across western North America, fire frequency decreased substantially following expansion of colonization by Europeans, intensive livestock grazing, decimation of Indigenous populations and suppression of Indigenous burning in the late 19th century. The combined record of fire occurrence from more than 800 forest and woodland sites, the largest network of tree-ring-based fire-scar chronologies in the world, illustrates this regionwide decrease in fire frequency. Reprinted from Swetnam et al. (2016) with the author's permission.

Community forestry in rural Mexico still exists and provides an important context to compare existing forestry strategies with traditional methods elsewhere and comparison in dendrochronological analysis. (Fule et al. 2011). As Martinez Torres discusses in his Thesis the multiple uses of fire within a conservation area raises important questions of multijurisdictional locations and the legacies and rules at the National and State level that are adapted to the practices and traditions of local and Ejido systems. The word ejido stems from a Spanish phrase for exito or "on the way out" given that these were communally managed lands that existed on the way out of villages. These lands varied by structure and decision based on local culture and traditions. These traditional practices and tensions with more intensive production are further discussed in a historic framing in the Lake Patzcuaro Basin in Michoacan Mexico (Fischer et al., 1999). The contemporary situation at one site in the Reserva Biosfera de Mariposas Monarcas (RBMM) is affected by population pressures and multiple uses at the intersection of National and State boundaries along with differences in local ejido and tenured management approaches (Figure 1.27, Left).

During a field site visit in June 2017 at the suggestion and invitation of Prof. Diego Salicrup at the National Autonomous University of Mexico (UNAM) at the Instituto de Investigaciones Ecologicos (IIE) who advises on the management of the Reserva Biosphera de Mariposas Monarcas, the author visited communities and landscapes across the reserve to document contemporary landscape practices, including mixed land use (agroforestry) practice at the village ejido scale in Central Mexico. Mixed land use and ejido tenured lands surrounding the Mariposa Monarcas Biosphere included livestock grazing and traditional agricultural and mixed agriculture-forestry practices.

The North American Monarch population has been stressed in recent years with a far-reaching impact across ecosystems of North America. These migratory flows are both ecologically and economically important to this region in Mexico as well as across regions in the Southwest and SouthEast United States (Figure 1.27, right).

Figure 1.27: Effects of a Prescribed fire on Migratory Winter Home of the Monarch Butterfly



In dialogue with Diego Salicrup, PhD, a researcher at UNAM's Institute for Investigations Ecologico, he mentioned the potential risk to this important overwintering site for the Monarch Butterfly population of North America to catastrophic fire. These indications are also evidenced in the works of Rodriguez-Trejo and Enrique Jardel, researchers in Forestry and Management in other regions of Mexico that are facing similar risks and management approaches in the face of reducing fuel build up and fire risk in forest systems, similar to those documented in Stephens and Ruth 2005, and also cited in Martinez Torres PhD Thesis (Rodriguez-Trejo 2004, 2011, 2015; Stephens and Ruth, 2005, Martinez-Torres 2019).

Based on this author's field observations in the below roadside photographs the RMBB has a mixed vegetation and mosaic landscape system with wood harvesting, timber production, crop production, including maize and mixed vegetation along with grazing areas on the outskirts of village communities. Small scale cattle grazing, sheep and goat herding dot the landscape with wide variation in scales of agriculture and food production mixed with forest systems (Figure 1.28). During this brief visit, the burning of crop residues, wood piles and other fire use including outdoor cooking and traditional wood stove meal preparation filled the air with diverse smells of hand or cultural burning. When temperatures declined around dusk, more fires and smoke was frequent throughout this system and particularly as descending the mountain slope, smoke collected in the valleys downhill.

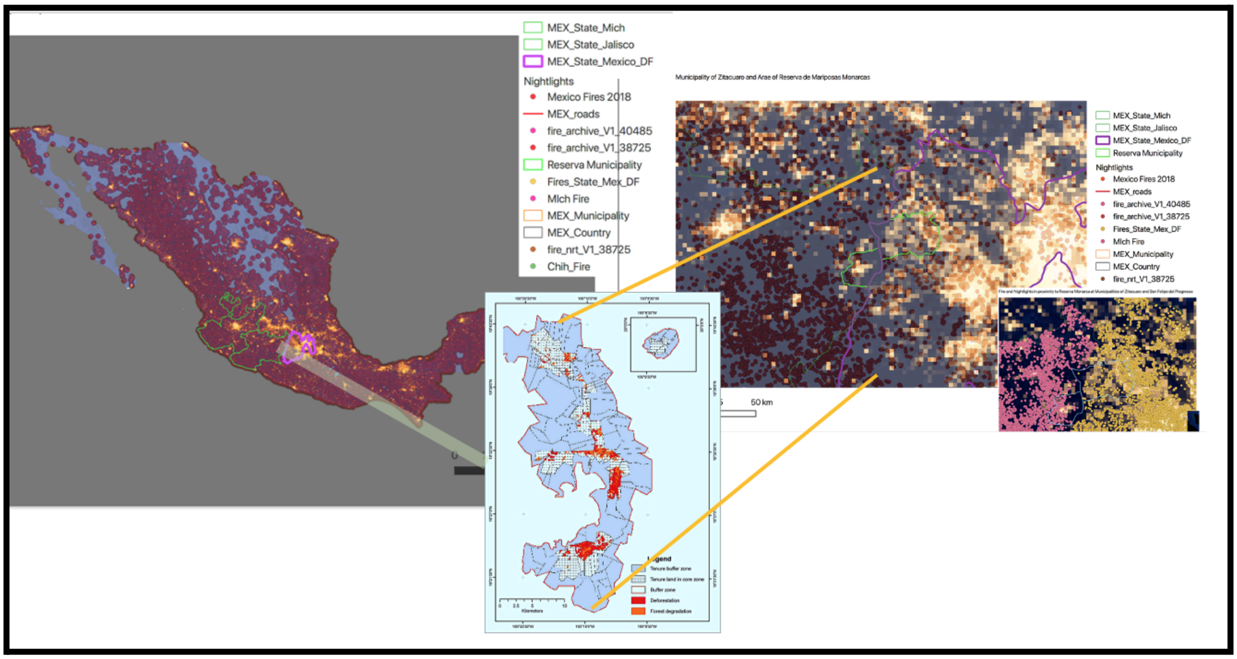
Figure 1.28. Inhabited Areas/Ejido Landscapes in the Reserva Mariposas Monarcas

These areas and activities reflect both the situation in the main reserve core areas as well as the peripheral zone of mixed tenure or more urban density. One way to measure this urban density and proximity to fire risk or active fire and ignition is the use of openly available Satellite imagery provided by NASA's VIIRS/MODIS satellite for North America. The Central Mexican States of Jalisco, Michoacan and Estado de Mexico are highlighted (Figure 1.29, left). The figure represents the general location and boundaries of the RMBB (Figure 1.29, center) and its approximate location in a close-up map of night lights, MODIS observed fire points and local and State boundaries (Figure 1.29, right).

As observed on the far right of Figure 1.29 the pink points represent detected fire in the State of Michoacan and the yellow points represent the points in the Estado de Mexico. The middle area represents a void of fire in the mountainous region in the area of the RMBB, providing evidence to the potential exclusion or suppression of fires in this area. This also only provides a relative visualization of the frequency with the available data at the time of this limited analysis that used annual recorded fires in a period in 2018. Further in-depth investigation and time series analysis would be required to provide more accurate and precise trends and statistically significant measures over longer time frames. Topographic and other physical features may also provide further indication of causal features of fire approach, management and risk correlated with diverse stewardship or management approach across these landscapes. These observations also indicate a mix of fire both within and outside the boundaries of the nightlight's images providing some evidence for a more fluid integration of fire in daily life within the urban populations present, which is also validated through field observations.

However, this initial attempt helps to frame the context of findings in Martinez-Torres' thesis and some indications for future management and restoration of fire processes in this zone.

Figure 29: VIIRS Fire Across Mexico and Regions Around RMBB Boundaries



Applying this type of data for broader understanding of North American geographies of fire including Mexico and California, we can consider the indications of urban density and fire activity of specific regions, administrative boundaries or demographic criteria. Considering watershed or more landscape level analysis is possible if we consider more county or municipal or other local boundaries in relation to urban extent and fire activity as shown (figure 1.30). Based on figure 1.29 and figure 1.30, a wide range of variation and management practices and systems of fire may exist across these landscapes and framed by legal and rule-making provisions in Mexico's legal frameworks and style of ejido or local indigenous land stewardship.

Figure 1.30: NASA Nightlights (2018) of Mexico regions with County/Municipal boundaries

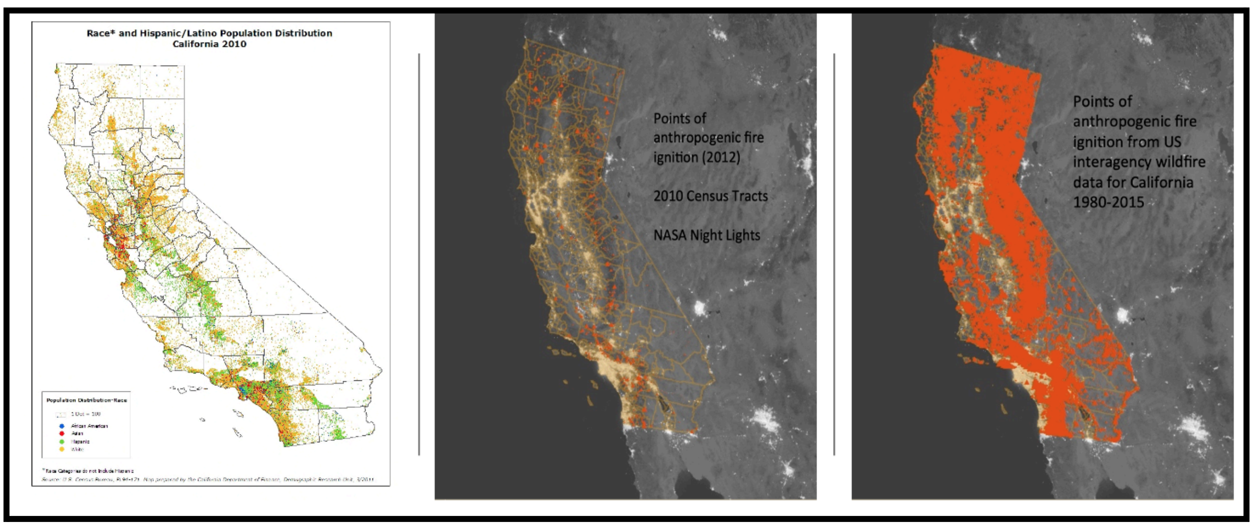
In the context of California, a similar approach developed by this author in 2017, including interagency wildfire data recorded from 1980-2015, Figure 1.31, right, overlapped with MODIS night lights data for urban extent Figure 1.31,center, for a single year (2012), provides an indication of the overlap of fire activity with specific communities, urban extent and by county. Findings from this analysis indicate increasing proximity (Euclidean distance) of settlement to fire ignitions over this period. Further analysis of the demographic make-up of those communities provided by California Department of Finance and Census Data from 2010 indicate that significant differences over fire landscapes exist across reported ethnicities and races.

While fire is generally excluded from night lights density throughout the State, there is more overlap in population distribution in Northern California and the Sierra regions, demographically represented by white or Anglo-European ethnic backgrounds, while Hispanic, African American and Asian populations exist in contemporary fire exclusion or suppression zones. For Hispanics, that are distributed proportionately across the State in rural areas including the Santa Cruz and San Joaquin Valley's and throughout historic agricultural belts in Southern California, there is very limited, or no fire present based on these records. Results may be a bit more mixed in the Southern Sierra

Nevada. African American and Asian populations are predominantly distributed in urban environments without active fire recorded.

While further analysis and research is required to address updated data, the use of different techniques and application of MODIS or other FIRM satellite data could provide further accuracy and temporal distribution of these effects. Nonetheless, Figure 1.31 provides some evidence to the perpetuation of racial and economic inequities based on the exclusion of diverse populations from fire and forest systems throughout the State. Additional impacts include the disproportionate impacts from major wildfire events on populations in the Central Valley and particularly the San Joaquin Basin, which suffers the worst air pollution and health impacts in the United States. Here agricultural laborers and specifically Hispanic populations are disproportionately impacted based on California health indicators and demographic data.

Figure 1.31: Demographic, fire ignitions, night lights data for California 1980-2015



As observed in the RMBB the smoke from activities in the mountains appeared to settle in the basins surrounding the area after the dusk fires were observed, similar topographic features impact the fates of smoke in the mountains and basins of the Central Valley. The story of migration of both the Braceros, their descendants, and similarities with Monarchs impacted by degradation of their habitable ecosystems, and linked vulnerabilities based on some of the evidence that has been presented above.

However, much still needs recording and this work seeks to begin to piece together components of those oral traditions and practices to contribute to filling that void. The Bracero Program in practice dislocated a generation of men from their local experience, lands, families and traditions and similar to the previous Spanish or Mexican periods in California, institutionalized a system of "peonage" more acceptable to the time through transportable farm labor quotas. This and subsequent guest worker programs designated for agriculture, further limited socioeconomic mobility, advancement and stability of employment for Braceros themselves and localized rural labor including indigenous groups that labored in the same fields as Braceros. The oral accounts of The Ahma Mutsun Tribal Band Elder Valentin Lopez growing up working in strawberry fields and amid grape picking laborers along the California Coast and the Central Valley during the 1950s and 1960s provide evidence to the interacting and potentially competing labor relations of these groups as discussed earlier (Val Lopez, UC Berkeley Lecture, 2021). More information on this may be found in related United Farm Workers histories and the Bracero Archives.

One oral account of a Bracero Program participant, Gonzalo Lomeli Uribe (1910-1989) originating from a campesino life in rural Jalisco, Mexico. Lomeli-Uribe had been a ceramicist, making adobe, making reed woven chairs, farming small family parcels by horse plow and cyclically burning fields after harvests of Maize, beans and other vegetables to prepare soils, grasses and the landscape for another season. His story has been transferred through oral interview by his children. By this account Lomeli-Uribe participated in the Bracero program from circa 1942-43 until the program later transitioned to other guest worker programs in the mid 1960s. During one of the first years participating in the Bracero program, his experience was recounted as being similar to those recorded in the Bracero Archive, a program of the Smithsonian Institution, George Mason University, University of Texas at El Paso and Brown University which provide data and reference for over 3209 accounts and recorded oral histories of Braceros and their family (www.Braceroarchive.org).

The translation of Bracero as a Spanish term is “one who works with his arms” or a field hand. These field hands numbering about 4.6 million Mexican nationals from 1942-1964 faced an array of injustices and abuses recorded in this archive, including substandard housing, discrimination, and unfulfilled or unpaid contracts. Many recounts include the shared humiliation of having to be stripped naked and be sprayed with DDT pesticide before being allowed to enter the United States after signing their labor agreement. Many of these practices as well as many longer-term experiences both positive and negative are recorded in the archive.

For Lomeli-Uribe, during the many years that Lomeli-Uribe participated in the Bracero program his children recall that he worked as a farm hand in places across California and recall addressing and receiving letters for their mother including references to strawberry fields, fruit and nut orchards, ranches and the specific locations of Watsonville, Oxnard Park, and places across California’s Central Valley including Tracy, “around Turlock”, Merced, Jamestown, Tulare and Fresno. Lomeli-Uribe after returning home to Jalisco following first seasons as a Bracero in the 1940s, had the experience of his brother in-law claiming Lomeli-Uribe’s parcel of land amid family complications during his absence in California. Without available land to farm he was forced to move with his young family that remained in Mexico to another town where he could work as a tenant farmer in the off season when not returning as a Bracero. Based on these circumstances, his experience in the Bracero program may have deprived Lomeli-Uribe of the opportunity to stay with his family in the place of his birth and subsequently ensured his dependence on this seasonal migration to California over the next two decades.

Another event recounted was a time that Lomeli-Uribe on a return visit home had somehow been thrown from the train. He arrived months after his expected arrival, badly injured a month after his trunk of luggage carrying goods and treats for his children arrived. He was reportedly returned to his sister's family home in his ancestral hometown in Jalisco by other Braceros who had taken care of him after the event. Lomeli-Uribe's experience was mixed. His experience in the United States paved some path and foundations for his children to live across and between these geographies over time, however the personal costs were significant and created significant stresses for those left behind and perhaps for those local or indigenous to California that the Braceros were forced to compete with as farm hands. The Bracero Archive provides other similar and dissimilar accounts.

The above migrations, both ecologically driven and driven by human policies, are framed around values inherent in the land and those that have developed the conditions over long historic periods across a variegated and mosaic landscape across geographies. With natural ecosystem events and human interventions, the interpretation of these values and absence of local decisions affect neighboring communities, institutions and ecological and wildlife features. For these reasons, considering the coupled interactions in complex adaptive systems framework is further discussed in Chapter two..

Considering the coupled human ecological impacts in that frame that cause human interactions in nutrient cycling, the impact of intensification, application of chemical additives to the landscape in the post war period and specifically during the years of the Bracero program and subsequent guest worker programs are important. Such impacts include the historic paradigms of fire exclusion and suppression, and what this has meant for air, soil and water toxicity during contemporary catastrophic wildfires and similar events that continue to shape the soil, water and vegetation structures into the 21st century in California and across North America.

As we consider what has been taken from the land in the context of "tending hands" with a history of local and indigenous knowledge and what has been left behind in intensity of agriculture, mining and extraction of resource and ecological imbalance of natural systems and nutrient flows, including phosphorus (Campo, 1997), we can learn from this particular period and early investigations including Harold Biswell's work whose studies of phosphorous and nutrient cycling reveal the benefits of prescribed burning to lettuce and barley cultivation from improved soil conditioning at experiments in the Teaford Forest (Vlamis et al. 1955).

Additionally, the important developments at the National level from industrial forest policy and particularly framing environmental justice debates on air pollution in the subsequent period must be critically discussed in light of the interrelated impacts to high severity fire if hands are not allowed to burn local vegetation in a lower severity and cyclical and frequent process. Brandt's 1966 critique of unreasoned agricultural burning by local groups in the journal of Agricultural Burning for the Air Pollution Control

Association and subsequent works and policies must be critically reviewed for their scientific merit and the boundaries of scientific investigation in a long-term life cycle context. Such policies can disproportionately impact vulnerable and historically excluded groups. In this context, learning from experience and emerging examples of sharing education and information about a process of application of fire by hands provides the opportunity to create new cultural, creative and scientific learning. For instance, in 1994, Merril discussed new kinds of multi-ethnic social and political structures emerging in San Joaquin Valley and parts of Northern Mexico, integrating people from diverse homelands and backgrounds, and creating new frontier identities.

The example of the voids created by the Bracero program and lessons from Butterfly migrations provide an opportunity to share perspectives across broad geographies, similar to the work of Ostrom and Hayes in comparing vegetation patterns across 84 forests in 15 separate countries, half of which were under National protection. They found no significant difference in vegetation density of protected forests and those that were not. The one criterion that made a difference was the direct involvement of local and indigenous populations. Regions where local groups were able to define rules had significantly higher density. These findings may be further exemplified in Fire Over Ahwahnee: John Muir and the Decline of Yosemite, contradicting the belief that protected areas from human intervention are the only way to conserve forests (Johnson, 2014).

The importance of identifying empirical records for historic fire regimes and understanding of the diversity and availability of nutrients and diverse species as climate change further stresses coupled systems responses can benefit by these new or expanded multi-ethnic and cultural research programs. After centuries of timber extraction, and intense use, the multidisciplinary approach including participatory research with hands on the ground and in the field can revitalize knowledge and tradition bringing new perspectives to the values of the land and learning across geographies (Best, 2019; Rodriguez-Trejo 2011,2015) (figure 1.32).

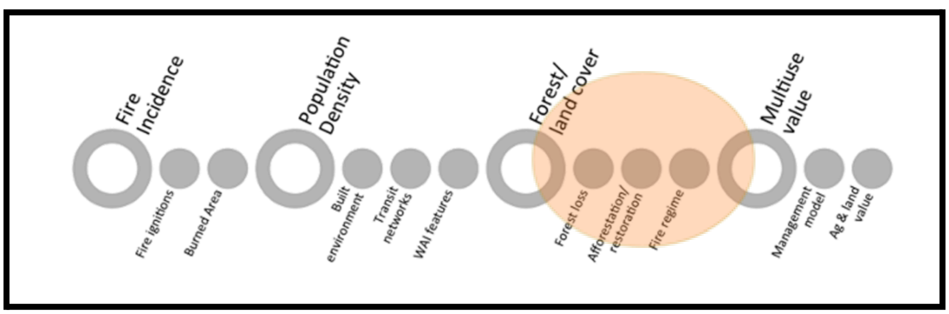
Figure 1.32: Participation in prescription fire in California and more examples in Mexico

1.10 Conclusion: Internalizing fire: participation, and learning from a Manzanita rising

The investigation of Bracero Burning as a way to internalize fire stems from an integrated approach to understanding a system of fire on the ground and a void of fire in the open. The author uses an English translation of Bracero to refer to working with the arms or in the field with “Hands” to demonstrate the universality of the concept of learning and gaining understanding through labor and participation in the field. Participation for this work has included ethnographic research, working side-by-side with forest researchers and fire ecologists, as well as participating in ecological restoration projects by lighting fire on the ground through a range of handheld tools and devices, traditional and contemporary to the Bracero period. This has included setting fire on the ground in diverse settings in California including at the University of Blodgett Research station in mixed conifer, grassland and hardwood ecosystems in Northern California and the Sierra Nevada. Participatory experience in sharing meals, dialogue and training with other researchers and volunteers, fire and land system managers included firefighters, prison labor and engaging in arduous labor providing the author first hand and primary observational data which informed the other interdisciplinary methods and theory in this work.

From a theoretical perspective, this chapter which introduces the concept of “Bracero Burning” engages with the human and ecological dynamics across institutional boundaries and the complexity of agricultural management models, which foundationally must account for labor on the land whether transported or otherwise. As demonstrated in the primary sources and archived data, the complexity of the management of agricultural systems or interacting land-use logics and resulting sociobiological interactions were further highlighted in recent events and historic catastrophic fires in California and elsewhere, following my initial synthesis in 2017 (Figure 1.33.). In the context of this evolving problem, while potential interventions lead to a somewhat linear increase in understanding of our environment, the effects may be more dynamic or chaotic, increasing uncertainty across the ecological system and human systems response (Deering et al, 2010; Kellert, 1993). Adaptive and novel (“localized”) approaches, as well as, an evolving and historical understanding that incorporates indigenous or traditional ecological knowledge systems into the problem space may be required (Hollings, C.S 1978, ;Lake et al. 2017) Institutions and agents responding flexibly in logical construction that emphasizes localized and frequent interactions, as process (internalizing fire), in the use and development of information, rather than predetermined milestones may be better situated to navigate the emerging, evolving challenges between fires and to foster stewardship across borders and boundaries (Knight and Landres, 1998).

Figure 1.33. Framing a decision space for a Labor over land model with multi-use values



Source: From D. Best, UC Berkeley Master’s Thesis, Energy Resources Group 2017

Such pragmatic considerations may follow from sociobiological processes that encourage the “in betweenness” of global and local decision amid theories of self-organization and self-determination (Berkes, 2019; Graeber and Wengrow, 2021) and the mutualism or nested systems between and across institutions and individual agents (Janssen and Ostrom, 2006). While human interactions with fire and forest are inherently local, they are also global, and so the logics employed in studying and managing this system must consider the top-down and bottom-up feedbacks and other network and regional effects related to movement and migrations, as highlighted in initial results of the electrical grid network and population distribution in 2017 shown (Figure 1.31.)

The images in this Chapter provide indication of the historic demographic migrations and concentrations of populations of agricultural labor migrants. The values that drive socio-ecological interactions and related policies frame the values projected onto the landscape with cumulative conditions developing over long historic periods. In traditional practice, creating a variegated and mosaic landscape across regions. With natural ecosystem events and human interventions, the interpretation of these values and multiple decisions affect neighboring communities, institutions and ecological and wildlife features. For these reasons, considering the coupled interactions in complex adaptive systems and the interactions within food systems through this narrative of Bracero Burning is a place to begin to address future prospects of at what scale and with what frequency do we choose to internalize fire.

Additionally, the polycentric nature of socio-ecological interactions through an iterative push and pull, affects our scientific understanding of these complex system dynamics. The requisite rule-setting to navigate existing and emerging boundaries between fires needs further attention. Situational awareness (Endsley, 1995) or rather local knowledge, and the ability to navigate or structure and develop a workable approach (e.g. appropriate learning rate, frequency of interaction, implementation of differentiated adaptive logics, etc.) to envisioning stability in land systems management in the face of natural system disturbance, requires a degree of historical knowledge and a frequency of in situ location based observations over time and a grounded connection (information that may use remote or simulation data, but has significant ground-truthing, (i.e. empirical or material observations/information)) and high frequency of grounded and connected neighbor interactions, a capacity that diminishes with increased scale and distance between boundaries (or greater landscape homogeneity).

Specifically, this can be related to the global and local knowledge systems that depend on memory, frequency and rates of work, and the openness and transfer of information systems. For instance, decisions to invest in light or heavy fuel treatment or iterative burning or mechanical thinning or other treatment also have complex technology and manufacturing tradeoffs with impacts both locally, to adjacent parcels, and global supply chains. Nonetheless, the management of structure within a forested or agroforestry land system, i.e. the spatial extent of a forest edge and the fragmentation of forest, agriculture and contiguous habitats are important topics in the ongoing monitoring and stewardship and conservation of land systems globally (Nowak, 2017; Finney, 2007, Fule, Bettinger, Stephens et al.) This sets the stage for related geographic and spatial economic questions of forest growth, rates of change amid shifting boundaries.

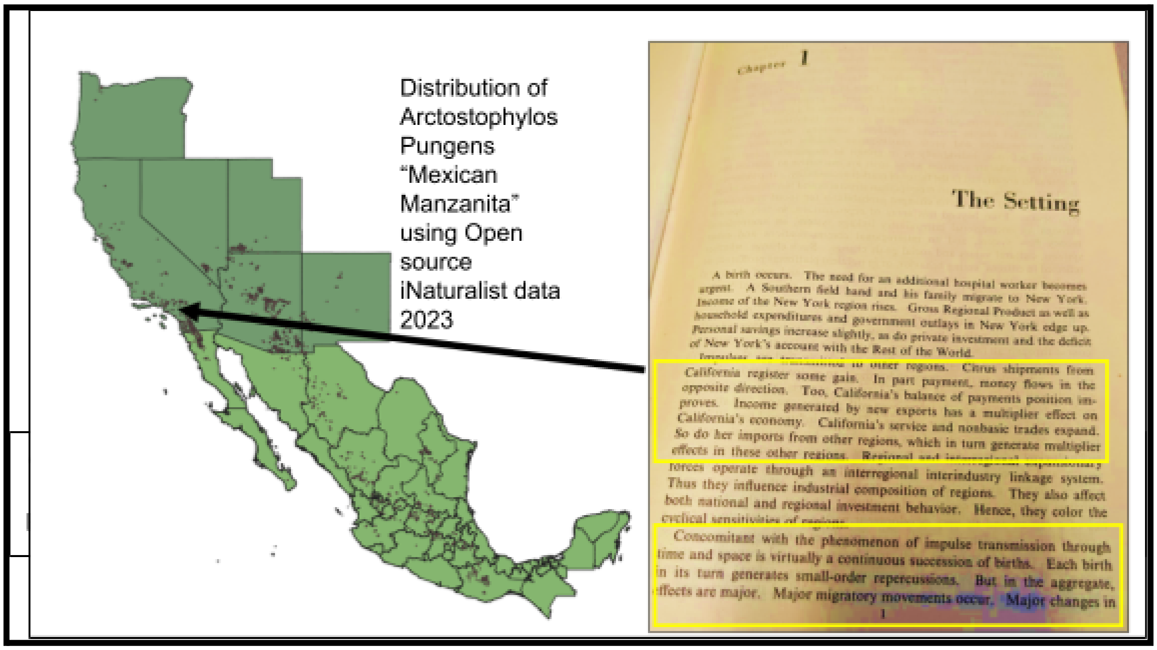
Additionally, while some reference was made to the post war period and industrialization, intensification and institutionalization of a military style suppression in the National Fire fighting and Forestry apparatus (Pyne,2015), there are significant global, regional and institutionalized processes during this period and contemporary land use decisions that are directly affected by the process of “Reinventing Fire” and the challenging resource intensity of “clean energy” technology solutions in mitigation and adaptation to global climate change. In his book, Reinventing Fire, American clean energy technology promoter, Amory Lovins develops some framing of “bold business solutions" to counter the effects of climate change and calls to action to develop key clean energy technologies. Throughout the book, though attempts are made to consider the energy efficiency and energy savings potential of newly adopted technologies, Lovins neglects to engage in many land use and labor challenges posed by these new solutions at large global scale in both the expanded resource utilization through extraction, embedded emissions through steel production, solar panel manufacturing, battery materials and the like that are required to advance this proposed revolution with its own environmental consequences. Very limited engagement into the lifecycle emissions and other life cycle and labor impacts that a related global transformation of infrastructure and resource allocation would entail, or the subsequent costs of learning or aligning existing infrastructure services, and labor that would be required.

While reinventing fire in the way proposed by Lovins has its discontents, the social and political costs and structure of labor over land, and continued resource intensity and mineral extraction and urbanization needed in the global supply of these products may be confronted by returning to the words of Lewis Mumford and others in the primary sources discussed earlier. These words point to tradeoffs in the scale and illusion of progress in urban landscapes, the costs endured by coerced or prison labor globally, whether in California's landscapes or in solar and clean energy factories or mineral extraction using incarcerated or "landless" populations in other parts of the world. Moreover the loss of ecological connection, biodiversity that may be coincident with these increasingly homogenous and risk prone landscapes requires us to integrate a more mutualistic understanding of our coupled systems of people and plants to adapt to global risks and climate events across boundaries.

In the last chapter of this dissertation an indicator species in the Mexican Manzanita is used to elaborate more on the ecological boundaries and plant response to fire based on similar questions of migration and adaptation or co-evolution over the geographic range discussed in this chapter. By learning from this species as a narrative object in the overlapping regional setting that Bracero Burning takes place, Chapter 3, sheds light on some of the learning about the diversity of people, plants and their uses that may be coupled with our decisions on fire risk and how to respond and restore as we adapt.

Any regional analysis must begin with scene setting, or a narrative description of the interacting phenomenon. The Interactions of the place, the people, their imagined habitat, their food, and their fire. In the book Methods of Regional Analysis page 1 of Chapter 1 begins with a description of the interacting regional economic network effects that are impacted by the cycles of birth and succession (Figure 1.34). As impulse transmissions occur each birth "generates small-order repercussions" and "major migratory movements occur." In the context of this narrative of Manzanita rising and learning from this chapter on Bracero Burning, plants and people and their food and materials source have the ability to migrate together in an interconnected landscape. Each birth and succession causes a lifetime of transportation network effects that move material, living systems across the surface of our planet.

Figure 1.34. The Setting for Learning from a Manzanita Rising



Source: Chapter 1, page 1, of methods of regional analysis, Walter Isard (1976)

The stories of migration and displacement also have network effects for species like the Manzanita and its mutualisms. As referenced by the regional setting the story of migrations and land use associated, have an effect on the placement of people and their labor and learning. The Internalization of fire across intensification of industry and the exclusion and suppression of fire also play a significant role in fire adapted species, such as the Manzanita. Where fire is fundamental to the “birth” and “succession” of this plant species. The cultural transformation based on the aggregate small-order repercussions of these changes have major effects. In the Bracero period, as citrus trees expanded across Southern California and the Southern Sierra foothills, and active fire was excluded, what were the effects on the regeneration of Manzanita seedlings?

As California continues to internalize fire and respond, reflect and review processes related to these multiple interdependent systems, a self regulating opportunity for the creation of new processes that address underlying ecological imbalances with integrated human systems exists. Responding in a more inclusive and transdisciplinary process may begin to leave behind the historic trauma inflicted in California and beyond its boundaries and allow for the creation and pursuit of an ecologically sound future structure for Science and the State.

As this Chapter ends and provides an initial investigation of the policy, human and ecological consequences of this consequential period 1942-1964 in the Culture of America, a hope is ignited that more research may build from the linkages and connections outlined in this frame of Bracero Burning. As an umbrella narrative with opportunity for further integrated scientific and human approaches required to do justice to this expansive topic, the previous historic roots and impacts of these centuries' long process and even longer histories in pre-colonization natural resource systems and the long term effect of labor on the land, technology choice and global conflict are motivations for later chapters presented in this work on Internalizing Fire.

Chapter 2: The Politics and Practice of Labor over Land: Internalizing People, Transport and Decision

An Abstract

This Chapter examines models of interaction between institutions, people and mobility across landscapes in a Politics of Practice, or rather an adaptive capacity framework to estimate costs and the scale of operations within a context of managed systems living with fire. As California and broader communities experience challenges in prioritizing approaches to both mitigate and adapt to changes in fire cycles perturbed by extreme weather events and population pressures that affect land use regimes, fire risk, and estimating the costs and reliability of specific actions is an important topic with both immediate policy and long term ecological impacts. This Chapter develops a framework to examine existing and potential institutional responses based on transport and field operations with a focus on distributed systems and institutional decision that allows for place based differentiated responses. A key outcome of this work is examining existing population distribution and various scenarios that may provide more responsive and diverse landscape management options. Through an analysis of workforce availability and transport options based on a novel modeling approach the results of this work provide both a theoretical framing and a practical model for cost estimation that may be used in a policy of investing in biodiversity and other learning. Development of scenario assumptions include primary research, practice in the field and institutional perspectives from stakeholders in adaptive management and practical response.

2.1 Introduction: Internalizing Fire at what Cost and Scale? An institutional analysis

The foundations of this research build from existing literature across the interdisciplinary fields of economic geography, fire ecology (fire science), and institutional analysis and adaptive decision. This chapter expands the historical economic geographic analysis of the first chapter into a dialogue of contemporary policies, institutional analysis and the theoretical scale of decision (internalizing fire) by looking at transport and operational decision models to examine questions of localized adaptive capacity. The central question of this Chapter engages interdisciplinary methods to investigate the role of distributed or local decision to explain the structure of operations in “internalizing fire,” and whether local decision provides for a more adaptive response to future fire perturbations?

As discussed in chapter one, the question of labor, coerced, forced or otherwise, incentivized people to move over the land via a range of modes and transport networks, as people may have moved locally, across regions and potentially back again. Yet, at the beginning of any analysis of regional development and the links between the city and the country, the evolution of the city-state and principles of resource use, trade and external relations of the polity require an examination of the histories of movement of people, migrations and sources of conflict including scale of infrastructure, modes of transport and units of measure and monitoring related to landscape and territorial transformation (Isard 1976; Agnew, 1994, 2013; Ostrom et al. 1961; Graeber and Wengrow, 2021; Mumford, 1969).

In this Chapter, a look at metrics of conveyance and private vehicle transport costs derived from literature and methods of quantifying and modeling regional flows in goods and labor provides data for the development of theoretical models of biomass and labor transport over land. Data from this analysis include references from transport economics, geographic works that discuss historical and traditional landscape stewardship, practices and associated costs to provide basic assumptions in an applied geographic analysis of the spatial scale and economic costs of internalizing fire. Particular attention to labor time associated with the important questions of population distribution, transport and other operational costs of vegetation management and land stewardship are requisite in determining an operational scale of managing systems under risk of catastrophic fire.

Catastrophic wildfire events across North America, and in particular events in California have compounded the complex challenges of addressing climate change and the coupled human ecology of landscape management. This has important implications for resource management that include forest and fire policy in the Western United States and beyond (Stephens and Ruth, 2005). In addition, the effects have led to expansion of risks posed by fire to the network of energy, transport and built human environment in an expanded fire season (Westerling et al, 2008). As the time scale, and frequency of fires has been augmented significantly in the 20th century, it is important to examine the complex interactions and fire histories including knowledge gaps in indigenous stewardship (Stephens et al. 2023) that have led to the current state of affairs and a shifting ecological frame that is linked to historic land use, management and contemporary labor decisions and practices that have long been coupled and decoupled to cycles of indigenous burning and localized approaches to meet the resource needs and stewardship objectives of local peoples and neighboring communities (Anderson 2005; Stewart, 2002; Biswell, 1999).

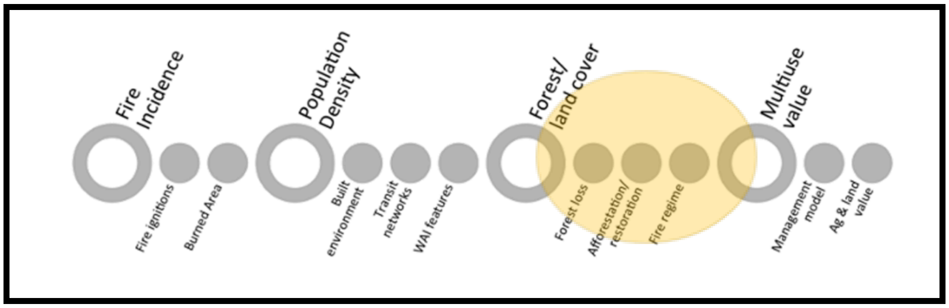
An important objective in the continual management of fire and ecosystems is to ensure accessible and localized food security for populations that face uncertainty from evolving natural and human caused food systems disruptions. The fire record in the Western United States and North America experienced a shift in the early 20th century linked to an expansion of large scale and centralized systems of agriculture, including forestry, driven by increased industrialization (Polanyi, 1944, Pyne 2015), as well as increases in population, labor migration and coupled shifts in intensity of land use and resource management. In particular, shifts in forest and fire policy during this period had long term impacts on vegetation structure and operational systems that augmented and effected the density and availability of biomass and materials for combustion and conversion either in managed, controlled or unintended fire events.

While existing literature examines the interplay of forest management policy and density of biomass availability for combustion over this time period, more research is needed, as discussed in chapter one to understand the effects of large scale human migrations, labor mobility and operational tradeoffs in the context of a localized economic geography of the region. Of critical importance to this work is investigating physical presence and decision frameworks, frequency of the coupled human decisions of managing fire to ecological systems stability, which can be investigated by analysis of population distribution, transport infrastructure and the related costs and scale of mobility of people and production.

2.2 Local lessons with fire: Learning from the commons and theories of transport

The complexity of these management systems or interacting logics and resulting sociobiological interactions were further highlighted in recent events and historic catastrophic fires in California and elsewhere, following my initial synthesis in a masters project engaging human presence and historic fire in 2017, (Figure 2.1). In the context of this evolving problem, while potential interventions lead to a somewhat linear increase in understanding of our environment, the effects may be more dynamic or chaotic, increasing uncertainty across the ecological system and human systems response (Deering et al, 2010; Kellert, 1993). Adaptive and novel ("localized") approaches, as well as, an evolving and historical understanding that incorporates indigenous or traditional ecological knowledge systems into the problem space may be required in restoration and resilience objectives (Hollings, C.S 1978, Lake et al., Stephens 2023). Institutions and agents responding flexibly in logical construction that emphasizes localized and frequent interactions, as process, in the use and development of information, rather than predetermined milestones may be better situated to navigate the emerging, evolving challenges between fires and foster stewardship across borders (Knight and Landres, 1998; Syphard, Millar et al. 2007; Larsen, 1995; Seidl, 2014; Berkes and Folke, 1998).

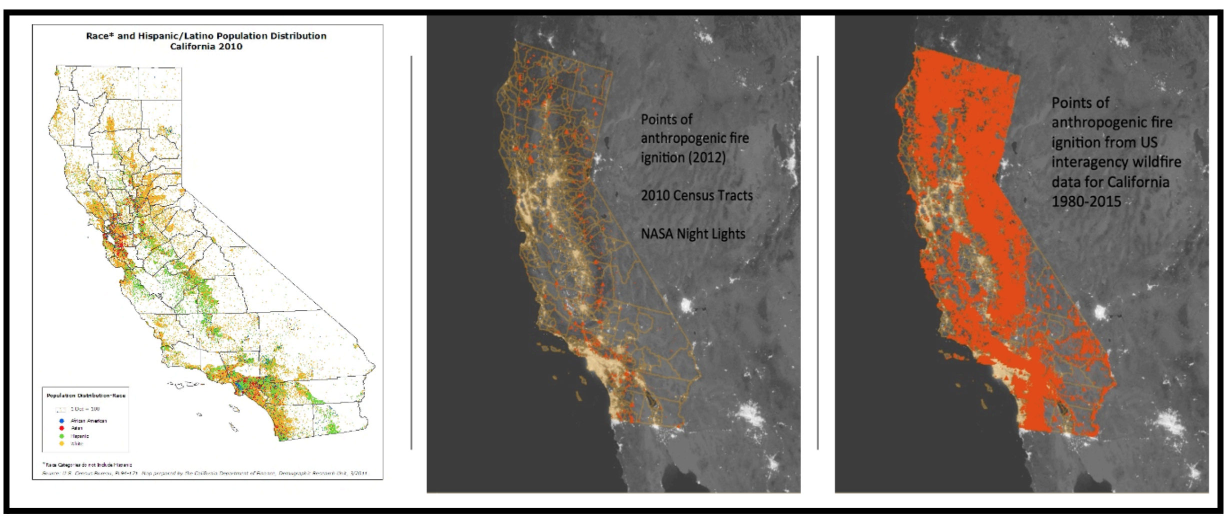
Figure 2.1. Framing a Fire Ecological Model and decision path with Multi-use Values



Source: From D. Best, UC Berkeley Master's Thesis, Energy Resources Group 2017

Such pragmatic considerations may follow from sociobiological processes that encourage the "in betweenness" of global and local decision amid theories of self-organization, self-determination and multiple uses of the landscape (Berkes, 2019; Bercke, 1999) and the mutualism or nested systems between and across institutions and individual agents (Janssen and Ostrom, 2006). While human interactions with fire and forest are inherently local, they are also global, and so the logics employed in studying and managing this system must consider the top-down and bottom-up models and feedbacks and other network and regional effects as highlighted in initial results of the electrical grid network and population distribution in 2017 shown in Figure 2.2.

Figure 2.2. Geographic Study region of transport, labor and management tradeoffs



Images: From Best, Dennis, (2017) University of California Berkeley Master's Thesis

The images provide indication of the historic demographic migrations and locations of populations of agricultural labor migrants. Social and ecological phenomena driven by human policies. These policies frame the values projected onto the landscape with conditions developing over long historic periods creating variegated and mosaic landscapes across regions. With natural ecosystem events and human interventions, the interpretation of these values and decisions affect neighboring communities, institutions, biodiversity in ecological and wildlife features. For these reasons, considering the coupled interactions in complex adaptive systems and the interactions across biomass transport systems is a place to begin to address these considerations of at what scale and with what frequency do we choose to internalize fire.

Additionally, the polycentric nature of these interactions through an iterative push and pull, affects our scientific understanding of these complex system dynamics. The requisite rule-setting to navigate existing and emerging boundaries between fires needs further attention and is discussed in later sections of this chapter. Situational awareness (Endsley, 1995) or rather local knowledge, and the ability to navigate or structure and develop a workable approach (e.g. appropriate learning rate, frequency of interaction, implementation of differentiated adaptive logics) is essential in envisioning stability in land systems management. In the face of natural system disturbance, a strong degree of historical knowledge and a frequency of in situ location based observations over time underpin this awareness with a grounded connection (information via remote or simulation data, with significant ground-truthing, in empirical or material observations/information) and high frequency of neighbor interactions. This capacity for a workable approach in situational awareness diminishes with increased scale and distance between boundaries (or greater structure homogeneity).

Specifically, this can be related to the global and local knowledge systems interconnections that depend on memory, frequency and rates of work, and the openness and transfer of information, communication and transportation networks. Decisions to invest in light or heavy fuel treatment, iterative burning or mechanical thinning, or other fuels treatment such as animal grazing also have complex technology and manufacturing tradeoffs with impacts both locally, to adjacent parcels, and global supply chains.

The early work of Stewart, Biswell, Helms and Stephens point to the multi-objective use of prescribed fire and other iterative local management options in addressing uncertainty and building resilience into landscapes that may be affected by extreme weather and other perturbations.

Other regional analysis frames by Isard, Agnew and Sauer and Mumford further discuss the role of networks, speed of locomotion and observation and the complexity of space and time in our cognitive awareness of our environment both built and natural. Sauer stated in his book Land and Life, “Locomotion should be slow, the slower the better, to stop at vantage points and question marks.” In these words, we can imagine the improved situational awareness that comes into view when an actor, observer or agent is able to take time for a decision process or to gather information across many senses while in the field as memories and previous observations emphasize the importance of human presence, creativity, and hence local decision.

2.3 From global models to local decision: Identifying gaps in a black box

As conditions of the Holocene and human impact on the environment led to increased risk of large-scale disruptions, across our water networks, energy infrastructure, housing and urban patterns, there is a growing recognition of increasing uncertainty in our world in the Anthropocene. As Holling and Gunderson among other risk theorists have established, humans are in need of considering new approaches to managing our systems (Gunderson and Holling, 2002). Whether that may be in the discourses on resilience or considering the frames of Watts and "alternative worldings" in recreating a new vision and multi-scale structures that may create greater stability and adaptive capacity in a future landscape.

The effects of fire risk, decision and management are the result of long-term dynamic and interacting sociobiological functions over varying time and spatial scales. A focus of this analysis is the role of local and operational decisions in adapting to a land stewardship that is responsive to the current ecological and complex systems challenges that extreme fire events have highlighted. In my 2017 Master's thesis (Figure 2.2.) a focus on the use of spatial data to provide some signal on the proximity of human activities to fire ignitions across California counties over a twenty five year period from 1990 to 2015 was used to investigate a model to determine variation of human and fire interactions amid different land use intensities in California based on infrastructure data. Night lights as a proxy for human presence have both economic and network infrastructure features. This data has been applied to many economic and planning analyses and integrated with other data into central planning models.

Beginning with an investigation into the knowledge gaps or spatial gaps in central planning models of "internalized fire" or energy systems and related limits to global systems modeling used in integrated assessments that inform global and national policy directions (policy, financing and institutional structures) the interaction between global and local knowledges is a scientific and cultural work in progress. Such models used to define climate change mitigation and adaptation strategies, policy discourse and practical implementation for technical assistance and capacity building have significant scientific and technical gaps and many assumptions by modelers, are either left unstated in a black box or maybe miscommunicated in a science or policy making communications environment (Breakthrough Study in Nature 2023, Victor and Cullenward, 2021).

What this means in practice is not straightforward, in fact given the various approaches, diverse geographies, landscapes and scenarios of change, there is no one way, one remedy or one quantitative tool or process to be employed. What exists may be more akin to an evolutionary process, integrating a diversity of technical tools and theory and interpretation of new systems of thought as discovered by Alexander Von Humboldt in his early journeys in North America that expanded human knowledge, but also considered the diversity of that knowledge and the documentation and processing of that knowledge in new ways (Wulf, 2015, The Invention of Nature).

The dynamic nature of natural systems that have existed and are pointed to in the origins of the coupled human and ecological systems that Kat Anderson discusses in her work and historical analysis of the relationship to fire, combustion and augmenting the landscape over long time scales - a process that has undoubtedly benefited from diverse and cyclical experimentation, whether results recorded or not. The results are more often recorded and interpreted through local cultures, rituals, communities of practice, our human DNA and in the tree rings, soil and artifacts left behind. However, today given the expansion of institutions and technological change since the enlightenment period, the dominant notions and accepted practice have not been equally recorded across civilizations. Glacken's Geneologies of Environmentalism points to East-West and North-South orientations in the important role of Latin America and the Far East in understanding how the environmental narrative, equity, and perhaps the future of science in socio-ecological coupled systems will come into being.

The nature of our science and discourse in the 20th century has been dominated by East –West orientation with no clear and evolving boundaries on what is East and what is West, established significantly by political and human conflicts. The prior centuries "North-South" imbalance has created a 20th century science dominated by this orientation. The impact has had much to do with our current understanding and framing of scale. In a 20th century dominated by large-scale projects, infrastructure, space, shipping, housing, urbanization, intense agriculture and its high input land and energy use, we are now struggling with the life cycles of these 20th century scaled objects as per Sauer and Mumford correspondence in chapter one. Hence, these large central planned infrastructures manifest into large scale disasters by wildfire, storms, droughts and hurricanes which wreck infrastructure and landscapes at unprecedented levels. Insurance and reinsurance companies may see things differently, and are exploring new ways to calculate risk (Sol Hsiang, Sayre, N. Lecture Comments at UC Berkeley).

In our economic models, the way we value our ecosystems interactions are incomplete, and so we see efforts to calculate externalities using econometric principles and further decipher the cost of carbon attempting to find a price and distinguish the value of almost anything we can imagine, from the air we breathe to the value of landscapes and their inhabitants (investing in Biodiversity Workshop Toulouse 2023, IPCC Chapter on Biodiversity). When a wildfire event occurs, the economic value of damages to the ecosystem including biodiversity loss is incomplete, as the real value of things is not adequately measured and the economic models in all their complexity are again proved false and incomplete.

Many energy systems and economic models omit disturbance events (drought, wildfire, wind throw) and their impact to biodiversity, biomass availability, land use change, and long term crop related economic impacts. Hence the realism of land use change and many biogeophysical feedbacks are not considered. There are limitations in the way the research and modeling can be conducted due to the five to six year cycles of scientific deliverables in IPCC and other scientific and political proceedings.

The associated scale of land use, actuarial risk and event probabilities are problematic in examining adaptive responses. The assessment of the scale of vegetation, sustainability metrics and wildfire effects that inform land management decisions are complex decisions (Agee, Li et. al., Konoshima) . Beyond traditional biomass availability and transport system logistical and distance problems, the risk of biodiversity loss and social implications add to that complexity (IPCC Chapter 2, 2023). More broadly, the scale of the farm, production site, risk exposure and the type of values and assets at risk in a small holder landscape versus an intense forestry or agriculture system, or public lands are quite distinct (Sayer, politics of scale). When considering economies of scale in implementation of specific management, often the intense farm or forest process wins out over the values rich human centered and bio-diverse (poly-cultural) system of smaller or agroforestry operations similar to those discussed in Berry's essay on Home Economics. (Berry, 1987).

However, if plurality of system types and correlated labor inputs or polycultural systems are weighted as more valuable based on metrics of biodiversity, ecosystem services or other component analysis, the institutional scale effect may benefit small holders. But this is not the way the majority of large system scale models are processed. They consider economy-wide, mono-cropping systems based on global commodities pricing as given and do not evaluate a more diffuse or smaller land use scale that could have significant adaptive system advantages over plantation or mono-cropped systems. To this point Walker discusses the intensification of agriculture and the links to financial services, the banking system and the process of credit provisioning in financial markets (Walker, 2001). And hence the need as Odum points out for a modeling for all scales (Odum, 2000).

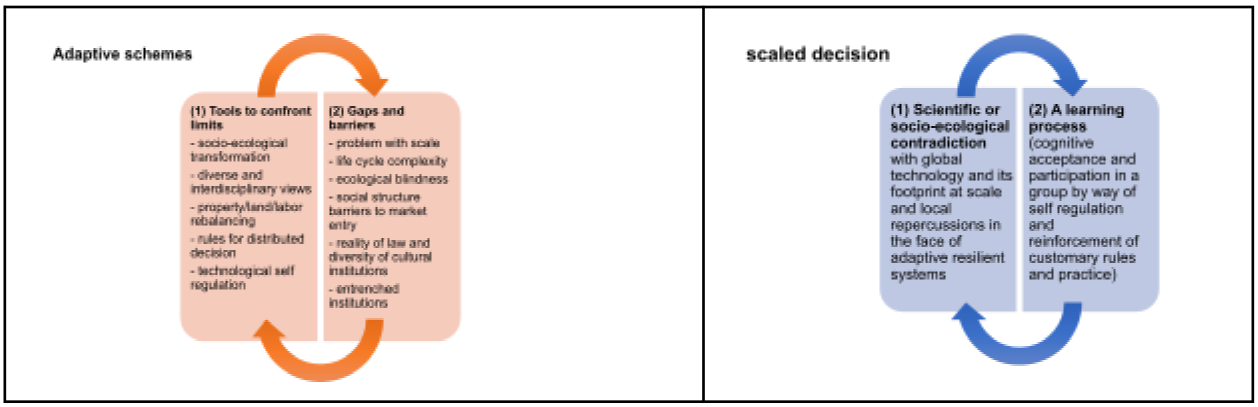
The modeling of energy systems and type of technology in the analysis is one way that the planning and systems designs and incentives are linked to the scale and type of crop. According to Foster's assessment of Leibig and Marx, " the long distance trade arising from the separation of town and country (and agricultural producer and consumer) was a major factor in the net loss of soil nutrients …and robbing the earth of its capital stock (Foster, 1997)." This raises the question, how are plantation systems, or managed forests and the geographic distance between objects factored into the inputs to such models? Policies that allow for "innovative" financial instruments – underpinned by academic modeling of futures, may work to extract wealth from rural communities and the labor, displaced or removed, that has long been part of small-scale operations .

Lohman and Johnson discuss the pitfalls of market creation, the incentives and expectations of the landed, corporate, industrial and financial actors in a climate context (Lohman 2010, Johnson, 2015). In particular, the discussion of the commodification of everything and the monetization of ecological processes needs to be considered, as much for how things are monetized and the risk of not monetizing something left out. As such, what is exogenous to the model, leaves that object as valueless. That is the difficulty in including something, but not everything in an economic model. It is also not easy to integrate models of different scales, diverse energy flows or system processes and factors that are non traditional – like local air pollution and its distributive effects by distance and wind direction (Westerling comments at UC Berkeley on the Uncertainty of wind models, 2019). Such a problem may be highly variable based on wind direction and time of day impacts. So how must we consider the broader imperatives of impact to human health, labor productivity and the rents associated with long term alternative fates for: land use, biomass, conservation value and human endeavor?

Bridging gaps: Learning with and through models

Transformation toward sustainable energy systems exists within a complexity of social, technological, economic and environmental aspects with many actors interacting through networks, emergent properties and adaptive learning processes (Bale et al. 2015). Complex systems theorists considering the energy frame must consider the coupled systems of technology, ecosystems, organizations and diverse human societies in a process of coevolution. The modeling of such complex systems goes beyond conventional economic modeling tools to consider the technological and behavioral interactions along with ecological and ecosystem limitations of adaptive schemes and scaled decisions as framed in Figure 2.3. The related techniques conjure a discussion of learning, decision-making and participatory process at varying regional scales.

Figure 2.3. Minding the Gaps: Adaptive schemes and scaled decision



For instance, consider a frame where a local economy and soil scientists agree that the state of the environment has been jeopardized by long distance trade. Such a confrontation or shock may then lend to the frame in figure 2.3. and application of tools to confront limits (1) and engage in a learning process more akin to a process of self organization and self regulation that exists adjacent to theories of usufructuary rights and customary law and the process of cultural learning, knowledge transfer and acquisition. The learning process sets out a behavioral or cognitive cycle, which is more process and institutional logic akin to Bordieu's discussion of the bureaucratic struggle for autonomy and to think from within the state, to self-regulate, regulate others, and the universalization or conformity to universal rules through reason and virtue operating in a circular process of mutual reinforcement (Figure 2.3. right).

Such planning in energy and resource endowments and constructions as discussed by Harvey and Walker emphasize inherent contradictions in relation to land and labor inputs and uneven geographic development. With a focus on interaction of how landscape is to evolve along with technological and labor inputs and capital flows in and out of the landscape. For instance, the transfer of information and to some extent, electrical energy, differs greatly from the transport and mobility of materials and commodities including waste and biomass and other energy system inputs. It follows that the potential geographic distortions in the creation and flow of electricity in the system and the amount of land needed for such energy generation in terms of energy density, or land use per kwh, are central questions facing California's energy system and the future of the State's strategic growth. Where the systems are sited, how markets are created or how capacity is traded (Participation in IEA EPRI Capacity trading workshop 2018). The inevitable infrastructure investments at varying scales - all determine the availability, reliability and the potential events that can perturb the delivery of services and potentially augment the adaptive system scale.

Again the question of natural limits in land use allocation and where and by whom the projects should be cited are once again front and center in population bomb in a Malthusian frame (Ehrlich, 1975). To complicate matters, the integration and global pressures of availability of affordable housing, and access to services and the interconnected questions of type and scale of technology, of distributed vs. centrally planned resources, lead us to another discussion of whether technology again nullifies "existing natural limits". However, again the land use tradeoffs, water rights and overall lifecycle analysis of these systems end up providing very complex environments for decision of how long term natural limits or boundaries are integrated into model assumptions. Or rather, whose frame enables the broadening of a decision space to include local impacts and community participation. These debates are discussed by Walker, in the context of social evaluation, a rational space economy or the domination of post war economic forces that interact with markets and distance costs.

Walker discusses California's history of private property and the expansion and seizure of land away from indigenous nations, imposition upon Mexican property rights and subsequent years of "fee simple, free labor, and competitive markets… built on the subordination of dark races". Walker well documents the land occupation by smallholders and subsequent corporatization of agriculture and land resource speculation, the transition to intensification and privatized land holdings driven by financial markets and access to credit in urban Northern California and San Francisco. The privatization of the public domain and removal of native populations from the land is further discussed and documented in Polanyi's narrative in the Great Transformation. What appears is the "change in the motive of action on the part of the members of society, from subsistence to gain… and a medium of exchange introduced into every articulation of industrial life (Polanyi, Great Transformation)."

Harvey's Contradictions' argues that eventually the persistence of this transformation leads to a moment of automation, robotization and ultimate displacement of living labor built upon the Taylorism and factory production in industrial agriculture and other spaces. But inevitably, if innovation or "internalized fire" lies in the heart of the labor input (source of value and profit) and the social component of work - then the eradication of labor, (a proxy for innovation) is at odds with the notion of the creative destruction of capitalism. If the labor power is taken out of commodification and the capital cycle, then, so too is the diversity required in a creative and innovation process that is necessary to underpin the cycle of capital circulation and the foundations of a capitalist free market. The ability for learning, innovation and creativity, particularly when connected to ecosystem and ecological understanding will be limited at the exact time when that “in the field” understanding is so critical to adaptation, biodiversity and socio-ecological systems science.

So then it may also follow - at what scale and evaluation of space, time and the place must we consider in the modeling of adaptive infrastructure and planning in the energy system and hence the economy. What is the distribution and scale of impact of the distributed energy system as an adaptive force for economies that allow for human labor and cycles that create, and recreate new and evolving complex systems?

A SKAILED Process towards Self-determined, learning and distributed decision

These techno-economic models that use historic economic data to evaluate the labor, operations and capital costs, do not consider legal, political-economic risks, or major catastrophic events (i.e. financial market collapse, wildfire, strikes, trade risks etc.) Hence these global models are not global in a holistic ecological sense, nonetheless, the complicated or “black boxed” nature of the analysis provides “non experts' ' with some placebo of accuracy in “prediction”. Therefore, omission of these clearly very real constraints, in such processes does not accurately reflect the economic costs of ecological impacts with full information in a practical sense.

What is optimal in the sense of social welfare, puts an unfair burden on localized or minority views and those dependent on customary agreements, traditions such as usufructuary rights for their labor and livelihood. These costs are not factored into such models and so an unverified, unsubstantiated burden is placed on the labor and the land, to optimize for the economies of scale of capital investment and the bold business solutions that are discussed by Amory Lovins in Reinventing Fire.

Such thinking legitimizes bold business solutions and private capital investment decisions along with public financing, leveraging capital and scale over the disproportionate socio-ecological coupled impact to the land and labor and the customary culture of the land and its inhabitants. For instance, usufructuary rights, a civil law term, the right of one individual to use and enjoy the property of another, provided its substance is neither impaired nor altered. As an example, a usufructuary right would be the right to use water from a stream for grazing livestock or in order to generate electrical power. Such a right is distinguishable from a claim of legal ownership of the water itself. Critical discourse over the labor and capital and the contradiction of urban hegemony over rural populations is necessary to formulate a regional and spatially explicit impact analysis, or formulate decision frames that allows for the full and transdisciplinary evaluation of the socio-ecological impact and the customary use of the land.

Inspired by Ostrom's work on the commons, a modeling framework that emphasizes process, rather than "inputs" and "outputs" may be better suited across scales as proposed in figure 2.4:

Figure 2.4. A Process focused adaptive framework across scales or (SKAILED) criteria:

S	1.	Scale of labor and capital flow is modeled as a closed system with self regulation
K	2.	Knowledge acquisition is inherent in the labor and technology adoption process (local content)
A	3.	Agnostic evaluation of urban and rural values amid reciprocity (i.e. population density, road density, conservation areas, local environmental pollutants, water rights.)
I	4.	Institutional regional boundaries are self-organizing, evolving and recreated
L	5.	Localized capacity development for participatory planning and inclusive agent involvement and information exchange
E	6.	Evaluation instruments and capacity sharing across local institutions are inclusive (multi-linguistic and technically accessible)
D	7.	Distributed (democratic) decision within a logic of situational awareness and social inclusion is integrated throughout

As such, land use planning and overlap with consideration for usufructuary rights and 'natural amenities' must consider population distribution, agricultural productivity and type, impacts to culture and livelihood, as well as, the energy density and life cycle flows of the infrastructure and objects placed on the land. Many of Elinor Ostrum's eight principles for management of common pool resources underpin the above proposed SKAILED criteria (Ostrom, 1990). Further, in Revisiting the Commons: Local Lessons, Global Challenges, Ostrum and co-authors including Richard Norgaard suggest that some of the most difficult challenges concern management of large-scale resources that depend on international cooperation, such as fresh water. Institutional diversity and diverse models like this proposed "SKAILED" criteria may be essential in preserving biological diversity in meeting such challenges (Ostrom 1999, Ostrom Norgaard et al.).

Towards metrics of a diversity of models: More, inclusive or better?

A suite of complex models and tools are currently developed by researchers at the International Institute of Applied Systems Analysis (IIASA), Laxenburg, Vienna. The institution is the product of a Cold War era LBJ American Presidential initiative with the Soviet Union originating from a RAND Corporation study to consider the benefits of a multilateral scientific body to expand systems science cooperation. The initiative was specifically to diffuse tensions in the scientific community to improve overall global and interdependent security.

"…When I came to Vienna (IIASA headquarters) I got a cool reception from the director general of UNIDO because IIASA was East—West oriented, and the UN North—South oriented. Later we became friends. He was an Egyptian, and he invited me to go to Cairo to see if he could replicate a national applied systems analysis institute.(IIASA WEBSITE 2019).

Today, there are 22 national members of this organization represented by the nationally funded research Council's and Academy of Sciences. The membership spans the Advanced Industrialized countries of Europe, North America, East and SouthEast Asia, but notably only Mexico, Brazil, South Africa and Egypt represent the regions of Latin America and Africa. Both Iran and Israel are also included in the current membership. Additionally, the early dialogue between "East and West", the United States and the Soviet Union portrays the language that alludes to the politics and interpretation of "management of the commons" and the orientation of the bureaucratic structure.

> *…a folder from 1968 referring to the International Center for the Study of Problems Common to Advanced Industrialized Societies. That name was decided in Sussex, when the Soviets weren't there, and they objected: "What do you mean by advanced industrialized society?" We said, "Well, we'll have a Center for Research of Common Problems." And they said, 'What do you mean by common problems?" We said, "We'll have a Center for Research." They asked: "Why research and not training?' We replied, "We'll have a Center for Study." They said, "Should it be a center or an institute? And, will it be written as center or centre?" That's when we all decided: "We'll have an institute… (IIASA Website 2019)"*

This dialogue actually rather succinctly conjures the challenges in shaping the form and structure of our modeling dilemmas, the language, objects and orientations created, and establishing whether this new creation is a symbol of science collaboration or a learning and "training" or acculturation process.

Biodiversity Gaps in a Global Management Model: The Exclusion of Fire

One of the active research areas at IIASA is to assess competition for land use between agriculture, bioenergy and forestry. IIASA's Global Biosphere Management Model (GLOBIOM) looks at these tradeoffs and claims to offer scientists and policymakers the ability to assess human welfare contributions from food, forest fiber and bioenergy. The model does this by considering the 18 "most globally important crops", though in the European Union model the crop number is 27. The model has a livestock component with feed flows, concentrations and breed types and also attempts to account for water inputs and now operates with 30 regional geographic areas. There have also been regional versions developed for Brazil and across the European Union, with additional data to create more spatially explicit analysis than the global model.

IIASA claims the model can offer assessment of integrated tradeoffs between ecosystem services, land use and resource competition. For instance: agriculture supply and demand forecasting, water and nitrogen demands for that supply, deforestation and forest degradation trends, scenarios for GHG emissions from agriculture and land use change, bioenergy feedstock supply, estimates of food and raw materials imports, adaptation and policy scenarios for management practice. The model incorporates "population dynamics, urbanization, ecosystems, technology and climate."

Drawing on geospatial and socioeconomic data the model is a partial equilibrium recursive process maximizing producer and consumer surplus. In a ten-year time step to simulate bilateral trade flows from a year 2000 baseline. Based on this description, assumptions reflect increasing intensification in agriculture and technological economies of scale and increasing production yield across these designated crops.

This Globiom model is now being integrated with IIASA's bioenergy model BeWhere to better assess the land use trade offs of renewable energy deployment. Initially developed at the University of Lulea, Sweden, BeWhere now works for the allocation of solar, wind, hydro and bioenergy production plants across the EU and with a national case for Finland. Finland is one of the largest processors of woody biomass resources and has integrated this form of industrial forestry and process as part of its climate change and renewable energy strategy. The BeWhere model for Finland is a spatially explicit energy planning system mapping a "cost effective" and "efficient" utilization of "limited natural resources" in an "environmentally sustainable manner." The model is designed to optimize a portfolio of bioenergy technologies, location of processing facilities and investment decisions, and related policy instruments. The model uses a national level dataset of forest resource (saw wood, pulpwood, energywood), historical industrial supply and demand (pulp mills, sawmills, combined heat and power and pellet industries (IIASA Website Bewhere, Leduc et al 2009).

The Bewhere model relies on a supply chain analysis of economic costs and GHG emissions to input variables (does not include water use, or other ecosystem and land use externalities). A transport network model is coupled with the feedstock logistics data to include roadways and railways (no freight shipping or international trade is yet included). The model includes large-scale deployment of "state-of –the-art technology", (Fischer Tropsch biodiesel, biomass integrated gasification combined cycle) and competing energy demand used in commercial and residential heating, as transport fuels and biofuel imports.) In the Finnish model, geographically explicit data is used with forest biomass aggregated at 10km grid size, along with spatially explicit heat demand and existing wood processing facilities. Geographic locations for optimal biomass processing plants are identified by supply chain costs based on feedstock supply, industrial competition and energy demand. The supply chain includes harvesting, collection, roadside chipping, transportation by road or rail, plant energy conversion, and energy delivery to demand locations. Resource allocation strategies are considered based on type, scale and use of resources.

What these models are attempting to do is not easy by any means, and the complexities of what must be added or taken away for the model to function are significant. For instance, economies of scale with biomass and materials flows cause multiple logistical problems between rural – urban transport and sites for harvest, processing and distribution at ports. Road and rail transportation incurs congestion and can lead to additional environmental impacts to local populations and costs of transport, all of these including traffic congestion and wear on infrastructure can cause extensive economic, social and environmental burdens on site and disproportionately affecting local populations.

Hence scale and resolution of data for location siting is critical to this process. Additionally, sustainability and operations management processes, the multiple demands and criteria and hence size of plants and process type are all highly interdependent. Therefore, the assumptions on classification and management process on land will significantly impact model outcomes. Here, boundary and network analysis and the scale of resolution and climatic factors are complex and highly uncertain. For instance, considering regional GHG mitigation policies in Globiom, BeWhere and other Integrated assessment models (IAM) leads to differing technology choices and related scaled outcomes.

Another important point related to carbon pricing discussed by Lohman, among many others, is that scale and location of bioenergy and carbon sequestration systems varies significantly under several integrated assessment models, responsiveness to policy incentives, supply and location of bioenergy feedstock, the selection of technologies represented and available storage potential and systems process assumptions. How land use and long-term emissions trade offs are represented across the IAM literature is split across land use sectors and energy system components. Land use models and associated emissions can be highly variable given questions of scale, land cover type and management approach in related models.

In these models emissions ranges of carbon dioxide (CO2) from fossil fuel combustion and industrial processes in 2030, 2050, and 2100 are wide for a number of reasons, including (i) the widths of the 2100 CO2eq concentration bins, (ii) differences in land-use CO2 as well as non-CO2 GHG emissions, and (iii) differences in BECCS deployment (Kraxner et al 2015). These assumptions tied to land use tradeoffs and interaction across energy, industry, urban residential and agriculture sectors become even more challenging when we consider the uncertainty and variety of inputs, end use and lifecycle of the land and energy inputs in production.

The Nature Conservancy is in the process of exploring related modeling, including a new scientific study to consider land use change interactions with Globiom to determine food related policy and land use implications. The current frame of Globiom expansion includes greater consideration of the intensification of livestock and feedstock inputs into the meat production process. Additionally, the model includes variables for the rate of urbanization included in the model and therefore may be augmented both by the metabolic processes of the cities, their extent and location (AGU side event discussion with Nature Conservancy consultant 2018).

All these have uncertainty built upon and integrated within models compounding more uncertainty, in the parameters of scale and period of deployment, innovation and learning rates by technology, land use variables that may differ by socio-cultural and socioeconomic frames by country and region. The interactions with climate, agriculture production and crop type and energy and nutrient cycling make the models complexity, somewhat indiscernible. This is to say nothing for the type of assumptions of policy triggers, pricing and sectors that are modeled or considered at the national or sub regional level.

Measuring the coupling of these technologies at the global scale poses dangerous pitfalls by not considering local specificities in ecology that may interact with these agriculture production and energy system and land use conversion costs (Nature Conservancy discussion at AGU 2018). The recent uptick in global fire events and catastrophic fire that poses risks to large scale plantation systems in California, Canada, Indonesia, Brazil and Elsewhere also pose a significant challenge to the application of the global models that have not integrated fire risk reduction measures beyond assumptions of fire suppression to value the biomass flows within these systems. This poses a significant challenge to the science of these modeling and economic tools.

Integrating decision into modeling and policy assumptions at a more localized scale

At the national level these assessments have been done to a finer degree considering the linking of Globiom model and the BeWhere model inputs that have been developed for Austria, Finland and a handful of other national and regional governments. However, the complications with sustainability criteria and land use implications across borders and lack of adequate assessment of potential distributive impacts to communities and individuals need serious consideration.

Areas of high vegetation accumulation, significant climate variability, drought periods and shifts in precipitation, may be specifically challenging and sensitive to model constraints because of the occurrence of stochastic, and extreme weather events that lead to disturbance by wind throw, storm, fire and other catastrophic phenomenon. The interaction with global policies to reduce emissions, deforestation, and degradation (REDD) and protection of biodiversity and other ecosystems services adds more complexity for the modeler and the assumptions on livelihood impacts, for the production of localized shelter, food and fiber. There is very little literature on geographically and spatially explicit features of the tradeoffs. as high level resolution data does not enable concrete evaluation of impacts or adaptive management strategies.

Given diverse ecologies across these geographies, is it pragmatic to consider a homogenous economic model across the span of study areas? Or perhaps we must go back to the coupled dialogue between the US and Soviet representatives at the founding of IIASA. Are these models for study, research and learning, or are they a “training” and acculturation tool? Critical factor inputs into these models such as the definitions of the “availability of sustainably produced biomass, livestock feed, type, population densities, projections of material and energy demand, and presumption of economies of scale” all have significant tradeoffs, that may not be best left for a small cadre of international scientists and technocrats to decide. Particularly, this is relevant given the high-level policy formulation and the limits in ecological, and biophysical understanding and interaction that comprise this essentially “economic” model.

The features of these models and aspects of social acceptance (or lack thereof) including the limits of practical applicability and consideration of biodiversity, among other community factors were openly discussed at government sponsored and scientific meetings, where this author participated and convened discussion on these critical points in Laxenberg, Vienna, Jakarta Indonesia and in Brazil from 2012 -2015 Figure 2.5.

Figure 2.5. Positive about negative emissions? IEA-IIASA Experts Meeting on Bioenergy and Carbon Capture and Sequestration, Laxenburg, Austria 2012.

Source: IEA-IIASA 2012 Experts Workshop on Bio-energy and Carbon Capture and Sequestration. Participants included energy modeling and policy teams from the IEA and IIASA (Author 6th from left)

As Jasonoff argues in a New Climate for Society, climate change produces discord, such as discussed above where institutions like the IPCC, IIASA and the OECD/IEA may continue to detach knowledge from meaning. As the meaning to impart actionable changes in lifestyle and society must come from our embedded experience and local behaviors, the actions and formulation from top down modeling and decision processes miss fine scaled opportunities and observational and participatory experience necessary to take the type of lasting collective and local action needed to address these large-scale system and global challenges (Jasonoff et al. 2010). Thus common sense approaches embedded in the relationship between individuals, communities and ecological processes, need to be further communicated to inform these modeling approaches. Likewise, the assumptions embedded in these models need to be openly assessed, vetted and recalibrated and simplified if they are to consider the real and actionable impacts to global communities and socio-ecologically coupled systems, for instance in the case of catastrophic fire and particularly those that have been impacted by the South-North discourse over the West-East contradictions.

While popular climate change business advocates like Amory Lovins, among others, have talked about “reinventing fire” and transforming our energy system, recent events in California, Finland, Canada, China, Chile, Brazil and even arctic fires, and countless other regions, suggest that whether there is some realignment of the global energy system, the fires will persist. We need only turn to the singer songwriter Billy Joel for his cold war era inspiration on the path forward. “…We didn’t start the fire, it was always burning since the world’s been turning…” We could argue the merits of Joel’s statement of causal interactions in the Anthropocene or Holocene, however, the message is clear that regardless, we must learn to adapt our models, institutions, and interdependent and collective action to our continued experiential conditions.

In the current fire experience in California, institutions are also coming to realize and reflect on the important local interconnections and indigenous cultural understanding to deal with global scale challenges and provide local solutions (Stephens 2023). As debates here in California, as elsewhere, on prescribed burning, mechanistic thinning vs. suppression and their associated “costs” continue, we may come to realize that the real “expert” may be the one that starts the fire, rather than the one that puts it out, or the one that modeled the system with all the world’s supercomputers. This expertise does not come from abstract models that try to fit the whole world of uncertainty into complex frames. Those with little connection to practical implementation, may lack a “global” or holistic knowledge of the problem which in fact may be localized. Rather, the facilitation of new and existing organizations to build and rebuild capacity, hone local observation skills and inference to respond as adaptive systems in diverse socio-ecological coupling is required.

A Globiom to BeWhere of Fire?

In the aftermath of catastrophic fire events in California, communities have developed their approach to fire safe councils, and homeowners, insurance commissioners, State energy and natural resource agencies develop new strategies and meanwhile, insurance providers and reinsurers formulate their stochastic uncertainty and probability distributions to calculate the “costs of resilience”. At this moment, what can this modeling community take away from recent events and the thin line between normative and subjective natural values and the energy system model assumptions they include? Ostrum and the management of commons may guide our response to consider the scale of resolution and infrastructure examined, the limits of what is included, and consider how the costs considered may need to be disaggregated, or heavily re-assessed from the stand point of weighting of localized capital investment, system resiliency, materials flows and operational costs and system flexibility (perhaps smarter, smaller and more socio-ecologically coupled grids, microgrids and SKAILED systems are in order). The United Stated Department of Defence is expanding their research and investment into microgrids with a plan to make 90% of worldwide bases energy independent (Lawrence Quil, NPR 2023).

And finally whether these models continue to persist, what stakeholders need to be brought in at the onset? Is the Nature Conservancy sufficient to advocate for local labor, communities, and diverse cultural and indigenous values? What “downscaled” participatory process are required for assessing “true values” and communicating and restoring real observation, inference and action so that at a minimum “Globiom may BeWhere of Fire” in our future local and interdependent security.

2.4 Spheres of Operation, Transport, Information Flow and Distributed Decision

Monitoring the anthropogenic impact of historic and modern fire regimes is critical to understanding how to learn from, use and coexist with fire. In some regions of the world, fire has been and continues to be integrated into daily life. In others, the focus on suppression and extinguishing fires from natural or working lands has led to multiple challenges and wide ecosystem and social impacts around the world such as pastoralist fires and conflicts in Laikipia, Kenya. Understanding the land cover dynamics and land use impacts from activities such as logging and grazing requires further spatially explicit interdisciplinary research. In particular, the impacts and interaction with water systems, drought conditions and feedback of fuel loads in Mediterranean, arid or dry forests and other regions also requires further study of vegetation effects, the impacts of burn area on landscape and land cover dynamics and how this may be affected by climate and global change. Global integrated energy and forest models highlight the critical role of forest management, conservation and avoiding deforestation to global climate change mitigation efforts (Tavoni et al). These spheres of complexity exist as we seek to require and further clarify the role and delivery of ecosystem services including biodiversity and consider adaptive approaches in forest management and land stewardship in this context of climate change and forest system resilience (Syphard, Options Forestry, Future forests under uncertainty).

Dougill et al (2012) discuss some of the lessons from projects in Africa and other parts of the world in managing resource programs to reduce landscape degradation and deforestation. Their study pulls from literature to highlight the importance of strong existing institutions, land tenure rights, open community management of resource decision-making, flexible payments or alternative livelihood schemes. Additionally, adapted institutional research relative to the areas of study must complement scientific research and provide capacity development and education and information flows at multiple levels. In considering spheres of operation and decision we may revisit Dolsak & Ostrom’s guidance for community based resource management as demonstrated below (figure 2.6). The first two guidelines emphasize the distributed operational process by users and accessibility of monitoring mechanisms.

Figure 2.6 Guidelines identified for community-based natural resource management

1. Rules are devised and managed by resource users
2. Compliance with rules is easy to monitor
3. Rules are enforceable
4. Sanctions are graduated
5. Adjudication is available at low cost
6. Monitors and other officials are accountable to users
7. Institutions are devised at multiple levels; and
8. Procedures exist for revising rules

Source: Dolsak and Ostrom

In considering the monitoring of resource use and compliance, availability of plant, biomass, and other organic matter or generally "fuels" for fire effects is a critical variable in the spread of wildfire. Fuels exist in and as part of complex and dynamic environments that are dependent on temporal and seasonal effects, vegetation type, existing structure, climate and water system variation, and the interaction with humans and other fauna. An expanding variety of approaches are used to identify, observe, characterize and monitor fuel conditions and map them and their interactions with fire effects, management, conservation and other scientific and human uses, including the decision of how, when and where fuel treatment may be applied. Here, place based observations that observe edge effects and structural change in a timely basis have important fire cycle effects on the management and transport of fire across the landscape.

More recent events, and the scale of the fire and forestry disturbances around the globe, have led to the advancement of methods and practices to apply new technologies as well as traditional and local knowledge into a better understanding of this dynamic problem space as envisioned in Figures 2.3. Novel fuel assessment and management approaches that integrate the current and evolving state of science and state of art are being applied to this problem. Dynamic models and basic science and experimentation are grappling with this complex adaptive decision space coupled with the ecological effects of human decision over time.

Existing optimization and dynamic modeling tools have to date factored in data and assumptions related to carbon content, landscape structure, land use change, management effects among others highlighted at various scales to account for many basic assumptions and parameters as highlighted in Figure 2.7 (Finney 2004/2006;

Heckbert 2010; Bettinger, 2015, Couture 2016; Thomas 2017; Konoshima 2017, Manna 2019). Importantly the decision variables of spatial location, timing and scale are fundamental to such an analysis from the onset(Figure 2.7).

Figure 2.7. Examples decision variables, optimization model assumptions

Source: Bettinger, 2015; Konoshima, 2017

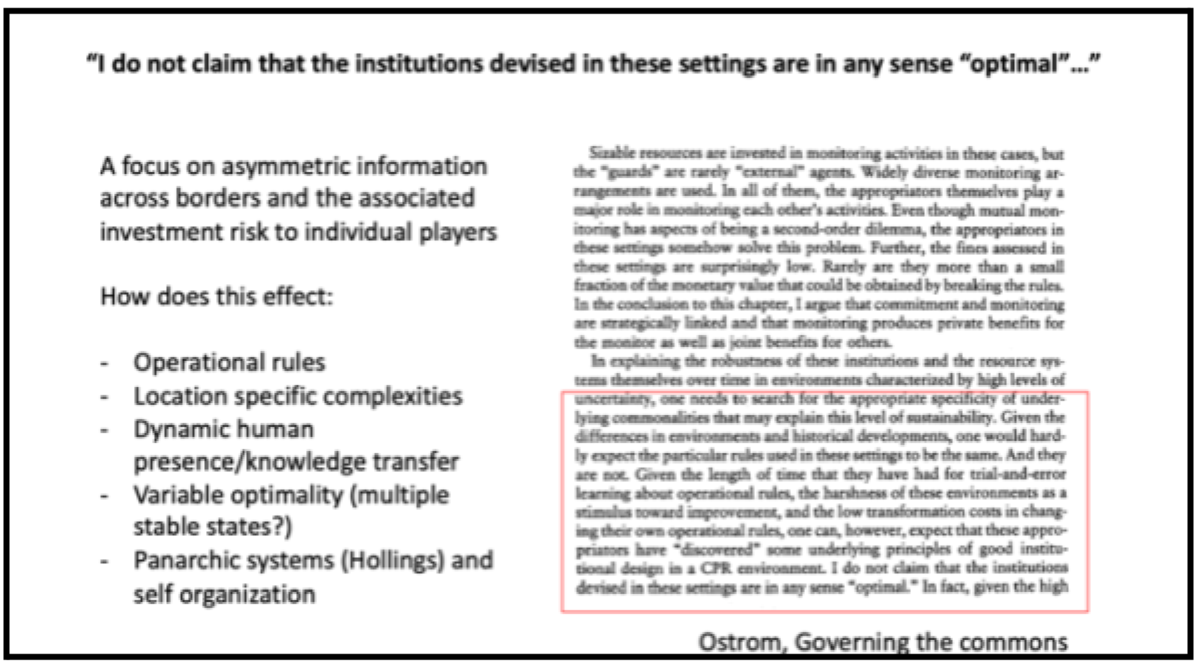
Yet critical questions exist across this complex adaptive system with multiple cooperating and competing players (agents) over a problem space with multiple, changing and overlapping structures, nested systems and objectives (Bercke, 1999, Tsebelis, 1992). In the author's 2017 Master's thesis, a focus on the use of spatial data to give some signal on the proximity of human activities to fire ignitions across California counties over a twenty five year period from 1990 to 2015 considered variation of human and fire interactions and land use and management models as key variables of fire ignitions. The complexity in determining the multi-use or land use values inspired a further advancement into the research of decision within complex adaptive systems.

The complexity of these management systems or interacting logics and resulting socio-ecological interactions were further highlighted in recent events and historic catastrophic fires in California and elsewhere following this initial synthesis in 2017. The dimensions of responses since then, further demonstrate the need to elaborate the nature of the interacting knowledge and decision systems and embedded information and institutionally nested systems associated with the flow of information and decision in these interactions.

In the context of this evolving problem, while potential interventions lead to a somewhat linear increase in understanding of our environment, the effects may be more dynamic or chaotic, increasing uncertainty across the ecological system and human systems response (Deering et al, 2010, Kellert, 1993). Adaptive and novel approaches, as well as, an evolving understanding of the problem space from an evolving cognitive or bounded rationality approach (Hollings, C.S 1978, Simons, H) and the use of new ecological theory, tools and models (Odum, Keeney and Raiffa, Heckbert, Wilson) may enlighten a way forward. Institutions and agents responding flexibly in logical construction that emphasizes thinking and behavior, as process, in the use and development of information, rather than predetermined milestones may be better situated to navigate the emerging, evolving and often fuzzy boundaries between fires.

Such pragmatic considerations may follow from sociobiological processes that encourage the “in betweenness” of global and local decision amid theories of self-organization (Berkes, 2019) and the mutualism or nested systems between and across institutions and individual agents (Janssen and Ostrom, 2006) Hence, one key challenge is the shifting or fuzzy information boundaries or multidirectional information flow between nested systems. As Ostrum highlights in governing the commons, the boundaries matter, as in Ostrom’s first design principle for enduring CPRs requiring “clearly defined boundaries.” Yet in dealing with CPRs that are part of larger systems, the nested enterprises or “multi-level governance” plays a significant role and to some extent exists in contradiction with the “clearly” defined boundaries Ostrum argues are required Figure 2.8.

Figure 2.8. A Focus on Ostrom’s CPR design principles and nested enterprise



One way to understand these interacting systems are agent-based approaches, which have been applied to many research fields and increasingly in land systems models (Heckbert, 2014, Li an, 2014, Kimbraugh, etc.) Further, work on the development of decision rules and agent interaction at varying scales when faced with uncertain or stochastic events is needed and a growing field of research to further expand in both social and physical sciences applications.

Operations and the decision to create ecosystem stability or fire resiliency

California and other biodiverse regions of Mediterranean climate face increased challenges from climate change, wildfire and drought that impact forest health, the economy, biodiverse habitat loss and impacts to a range of ecosystem services and features of which surrounding communities rely. However, the associated challenges are complex across both human and ecological domains. Particularly, in the context of increased fire severity and impacts to forest systems, there exists much debate about the cost-effectiveness, timing and spatial distribution of fuel management efforts and varying approaches (Stephens and Ruth, 2005). In the Western United States, several studies have demonstrated the reduction of fire severity from fuel treatment. But as this hazard exists, there is not one type of fuel treatment, but a combination of options and strategies that must be developed to address management objectives. These include not only the choices of technology, spatial distribution and structural impact to canopy and stand characteristics, but also impacts to the subsurface. For instance combinations of prescribed fire, mechanized thinning, or a combination of thinning and pile burning, or prescribed fire, grazing and select harvesting or clearcutting all may lead to differing ecological and economic results.

Forest fuel treatment optimization models and related fire and forest management models may consider ecological stability with optimal control. Foundationally, the modeling of fire risk requires fuels modeling over space and time (Chung et al.), with various approaches in the optimization literature in accounting for variability, stochastic uncertainty (Liu et al 2013) and ecological effects of fire events. Models and methods for estimation for the cost effectiveness and economics of treatment optimization at the landscape level may impact broad forest management objectives, and in particular in the context of recent large disturbance events (Little Hoover Commission, 2018).

The practices and the results of these treatment types require ongoing research as well as a reflection on the existing policies that may limit the application of these methods (Stephens et al, 2010). Related forest policies, air quality regulation, environmental protection, endangered species, habitat priorities and ecological analysis must integrate new analysis from this field of “Adaptive Logics” to adjust to the changing conditions of the forest and allow for adjustments in decision-making across areas that enable effective experimentation and scientific methods to respond.

Availability of fuels for fire effects is a critical variable in the spread of wildfire. These fuels exist in a complex and dynamic environment dependent on seasonal effects, vegetation type and structure and natural variation that exist in all natural systems. A variety of approaches are used to identify the fuel conditions, measure and map them in the context of fire effect, but also to determine where, when and how a fuel treatment may be placed. Biomass combustion is a process that varies by vegetation type, climate conditions and across legacies of management; however, some specific features may be applied across geographies with the application of shared learning across similar landscapes. For instance novel fuel assessment methods may be developed and applied more broadly (Thomas, D. et al 2017). A process focused framework is required to develop a fuel treatment optimization methodology that may be applied over a longer dynamic time frame incorporating methods from existing fuel models that can expand knowledge and learning tools of fire spread along major pathways (fire behavior modeling paths) (Finney 2004/2006, Options forestry, Li et al, agent based modeling)

Throughout this process there are specific features such as the (1) spatial externalities, that may include both biophysical and ecological features affected by atmospheric conditions at each step and unit of analysis, secondly, (2) the stochastic nature of events and ignition sources that affect the timing, scale and location of events across biophysical features and the dynamic longitudinal impact of decision-making across time steps. Finally, (3) the complexity of strategic decision-making response and options in deciding if, where, when and how to implement optimal treatments - that relate to objectives, institutional and policy barriers that are heavily impacted by social behavior and expectations. This complexity and interaction is highlighted along the varying levels of interactions and decision-making. If the objective is to manage the system to provide stability or in essence, forest health and resilience in the context of increasing higher severity disturbance and changing conditions of climate change, management needs to consider the range of states that may contribute to long term or ecological stability, however that may be defined.

For instance, low severity fire disturbance or fuel treatments may leave community structures and parameter values relatively unchanged in a global analysis, but more biologically resilient at a local level. In this context, defining the local stability of a community is essential. However, within this framework assessing the values and framing these subcategories as outlined below of the complexity-stability theories is not void of uncertainty or the bias of weighting values for a range of definitions and variables. A complexity-stability hypothesis may have three specific dimensions 1) complexity 2) stability and 3) a variable of interest (Odenbaugh, 2000) and broadly reflect the below characterization as subsets of these three dimensions (Figure 2.9.).

Figure 2.9. Definitions in a complexity-stability hypothesis

a) Stable: a system is stable just in case all the variables return to initial equilibrium values following perturbation.
b) Resilience: how fast the variables return to their equilibrium following perturbation
c) Persistence: how long the value of a variable lasts before it changes to a new value
d) Resistance: the degree to which a variable is changed following a perturbation
e) Variability: the degree to which a variable varies over time

Source Odenbaugh, 2000

As this decreased resilience is exacerbated, there is an increased likelihood of a pulse perturbation that may lead to biodiversity loss and species extinction. This type of pulse perturbation is more similar to the high severity wildfires that have been increasing over the Western United States. Returning the historic fire regime or frequency of fire to a more resilient state more similar to the persistent perturbation with higher frequency of small or prescribed fires, may increase the forest system resilience (Helms 1979, Stephens and Ruth, 2005). Thus, more variability in response may have an impact on heterogeneity and potentially more globally stable ecosystems. Given the current state of many forest systems in California, the large scale perturbation with single frequency and pulse are more representative of the systems under a high fire suppression rather than continual fuel treatment regime.

A Fire and Feedstock that moves: Spheres of biomass transport and costs of treatment

While specific subsidies and mandates have been established to incentivize the transport and use of biomass resources in the energy supply in the United States, their effective use and implementation face significant obstacles based on the increasing operational costs which include transport fuels and labor. Figure 2.10. demonstrates the differences in adoption by region in the United States and provides examples of the potential interactions between the price of feedstock at farmgate and the location of coal fired power plants across the states that have been an economic driver for forest fuel reduction in other geographies.

As demonstrated in the figure the Renewable portfolio standard and renewable fuel standard have led to some higher biomass prices colocated in the Southwest with large coal fired power plant generation. The Renewable Fuel Standard (RFS) has led to higher energy and commodities prices in Midwestern and Eastern states irrespective of coal-fired plants due to application in the transport fuels mix. For bioelectricity the Western States represent a very low share of bio-electricity across all non-hydro renewables.

However the impact of competing electricity generation from natural gas and other lower renewables pricing has led to dedicated biomass plant closures in California. In part, the costs of transport, utilizing gas powered internal combustion truck transport, and fuels price are a significant factor in determining the sustainable supply of biomass at reasonable cost for such plants, the same is relevant for any biomass utilization case including timber products and the application of residues for compost or other waste processing.

Figure 2.10. Demand for Biomass for Renewable Energy Targets in the U.S.

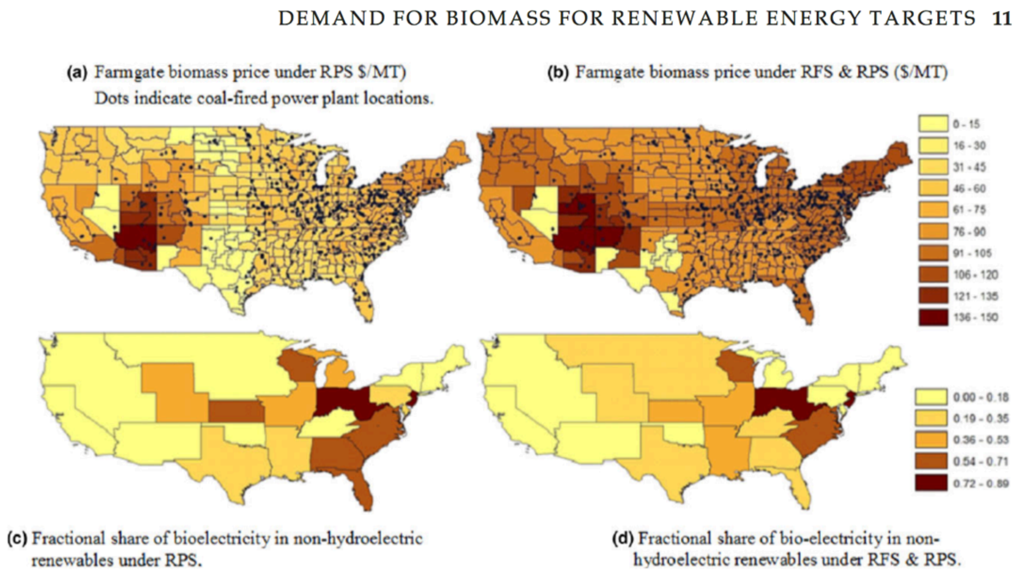
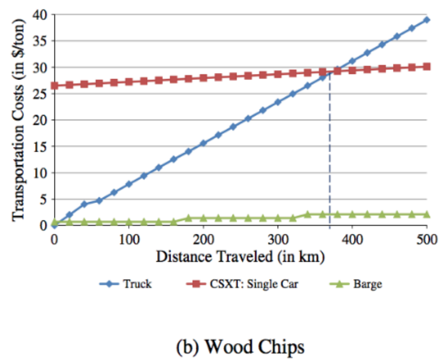


Fig. 3 Effect of alternative policies on regional biomass price and bioelectricity. (a) Farmgate biomass price under Renewable Portfolio Standard (RPS) ($/MT). (b) Farmgate biomass price under Renewable Fuel Standard (RFS) & RPS ($/MT). (c) Fractional share of bioelectricity in non-hydroelectric renewables under RPS. (d) Fractional share of bioelectricity in non-hydroelectric renewables under RFS & RPS. Dots indicate coal-fired power plant locations.

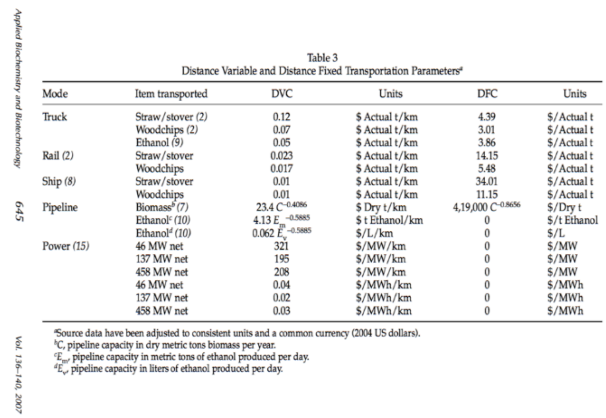
Source: Oliver and Khanna, 2017

A preliminary analysis of transport costs associated with delivery of 25 ton loads on chip trucks as determined as an average loading of chip trucks based on a 2012 USFS report (Thompson et al, 2012) is developed below. To estimate some fixed and variable costs of the load transported, two referenced studies provide a distance measure of transport. One study based on load rates and costs of transport, labor and fuel in a Finnish forest products transport study provides variables based on distance traveled as shown in Figure 2.11 (Laitilla et al. 2016). A second reference price is based on a study in North America (Alberta) that uses both fixed costs per ton and variable cost on a per ton basis. Costs provide by Seary et al as shown in the figure, demonstrate the difference between a per load cost including equipment for loading at site across different bioenergy feedstocks and transport types. Transport fuel costs have increased significantly since these studies were published with significant impact on cost effective vehicle distance traveled.

Figure 2.11. Comparison of transport distance and cost across carriers



(b) Wood Chips



Applied Biochemistry and Biotechnology 645 Vol. 136–140, 2007

Table 3
Distance Variable and Distance Fixed Transportation Parameters[a]

Mode	Item transported	DVC	Units	DFC	Units
Truck	Straw/stover *(2)*	0.12	$ Actual t/km	4.39	$/Actual t
	Woodchips *(2)*	0.07	$ Actual t/km	3.01	$/Actual t
	Ethanol *(9)*	0.05	$ Actual t/km	3.86	$/Actual t
Rail *(2)*	Straw/stover	0.023	$ Actual t/km	14.15	$/Actual t
	Woodchips	0.017	$ Actual t/km	5.48	$/Actual t
Ship *(8)*	Straw/stover	0.01	$ Actual t/km	34.01	$/Actual t
	Woodchips	0.01	$ Actual t/km	11.15	$/Actual t
Pipeline	Biomass[b] *(7)*	$23.4\ C^{-0.4086}$	$ Dry t/km	$4{,}19{,}000\ C^{-0.8656}$	$/Dry t
	Ethanol[c] *(10)*	$4.13\ E_m^{-0.5885}$	$ t Ethanol/km	0	$/t Ethanol
	Ethanol[d] *(10)*	$0.062\ E_v^{-0.5885}$	$/L/km	0	$/L
Power *(15)*	46 MW net	321	$/MW/km	0	$/MW
	137 MW net	195	$/MW/km	0	$/MW
	458 MW net	208	$/MW/km	0	$/MW
	46 MW net	0.04	$/MWh/km	0	$/MWh
	137 MW net	0.02	$/MWh/km	0	$/MWh
	458 MW net	0.03	$/MWh/km	0	$/MWh

[a]Source data have been adjusted to consistent units and a common currency (2004 US dollars).
[b]C, pipeline capacity in dry metric tons biomass per year.
[c]E_m, pipeline capacity in metric tons of ethanol produced per day.
[d]E_v, pipeline capacity in liters of ethanol produced per day.

Source: Laitilla et al 2016 and Searcy et al 2007.

Based on these references transport costs were estimated in the below California focused analysis 8on distance increments on fewer than 50km, 100km, 200km, 300km, and 400km. These distances are represented in the later QGIS based analysis. The total costs for Searcy et al. are consistently higher than the more recent Laitilla costs which would be highly dependent also on fluctuations in truck fuel price. However, the difference between both prices does converge over longer haul distance. At shorter distances <50km there was a 23% price differential however at <400 the price differential was only 3.3%. The Searcy approach led to a cost spike differential at the <100 km distance but proceeds to reduce over longer travel distance. However, such transport costs over consistent periods would lead to a significant cost and life cycle impact over the lifetime of a large-scale project.

Figure 2.12. Estimated transport distance costs of a 25 ton chip truck payload

Cost $/ton	Distance kilometers (km)				
	<50	<100	<200	<300	<400
Truck (Laitilla et al. 2016)	$5/t	$7.5/t	$15/t	$23/t	$30/t
Searcy 2007 DVC $0.07/km	$87.5	$175	$350	$525	$700
Searcy 2007 DFC $3.01/t	$75.25	$75.25	$75.25	$75.25	$75.25
Total Cost Searcy @ 25t	**$162.50**	**$250.25**	**$425.25**	**$600.25**	**$775.25**
Total Cost Laitilla @ 25t	**$125**	**$187.5**	**$375**	**$575**	**$750**
Cost differential	**23%**	**25%**	**12%**	**4.2%**	**3.3%**

To demonstrate the average cost of bioenergy plants and processing capacity Searcy provides analysis over different bioenergy plant types, which include “small” and “large” plants. Based on this analysis the average driving distance for wood chip processing plants for small plants is 68 km and for large plants 118 km, Figure 2.13. Estimating a range of plant travel distances within 200km provides a realistic maximum regional scale for comparison.

Figure 2.13 Comparison of feedstock conveyance at varying scales

Processing plant parameters	Small		Large	
	Straw/stover	Woodchip	Straw/stover	Woodchip
Biomass				
Biomass feed (actual Mt/yr)	0.269	0.427	2.69	1.28
Draw area (km^2)	6125	9500	61,250	28,500
Average driving distance (km)	55	68	173	118
Ethanol				
Ethanol yield (t/d)	174	83	1743	315
Ethanol yield as fraction of dry mass (wt%) *(5)*	25	11.6	25	11.6
Ethanol pipeline diameter (in.) *(10)*	4	3	8	4
Power				
Capacity (mW)	50	50	500	150
Thermal efficiency (LHV [%]) *(4)*	38	38	38	38
Availability (%)	90	90	90	90
Parasitic load (%)	8.5	8.5	8.5	8.5

Source: Searcy et al 2007

Additionally, the Searcy et al analysis provides a reference across different transport options to consider the percentage of costs incurred from distance variable costs (DvC) vs. distance fixed costs (DFC). High density biomass has the potential to reduce transport costs. As the biomass has physical properties similar to grain the current grain transportation system may be applied with analysis based on grain and woodchips. As regression analysis indicates transportation costs for densified biomass will be impacted by transportation distance, volume shipped, transportation mode used, and shipment destination (Gonzales et al. 2012), spatially explicit location based analysis is important to derive accurate costs.

A California Case for Cost effective feedstock transport from a managed research forest

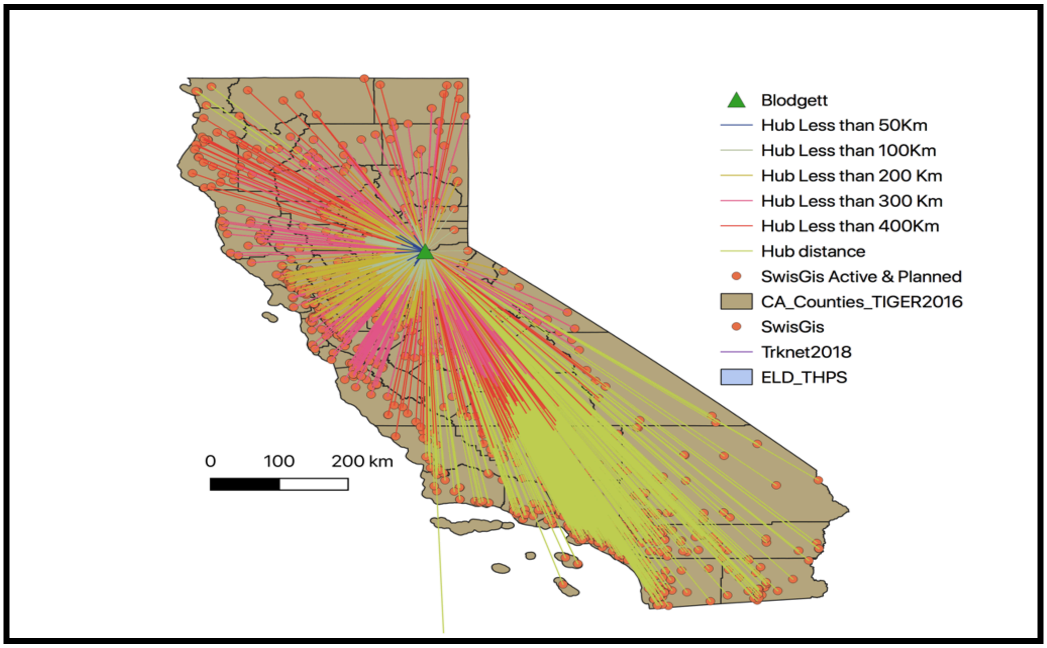
A term used in discussion of utilization of biomass, “cascading” frames the discussion of prioritization in application of these materials wherein “material use of wood should be prioritized over energy use of wood”. The IEA Bioenergy task group discusses this concept in the context of EU energy policy and the implications for international trade and bioenergy markets (IEA Bioenergy 2016). This section considers the economic and ecological applications the integration or cascading of a range of applications from timber production, forest management practices and applications framed in a broader set of decisions affected by energy, forest management, GHG mitigation and climate adaptation strategies in the context and consideration of transport costs.

The optimality of GHG mitigation and waste reduction approaches from biomass conversion facilities is a critical question as we think about the integrated challenges at the intersection of land use and energy systems. Beyond biomass combustion facilities, there are additional applications for wood waste of forestry related residue and materials that must be considered. This case study considers a location based analysis of California's managed forests, biomass and waste processing facilities. The Scale of operations and processing plants impact spatial distribution and biomass supply allocation. Biomass conversion processes such as anaerobic digestion or fermentation, composting, trans-esterification, or rendering, waste-to-energy facilities that handle municipal solid waste (MSW) may be considered for Waste Sector applications that can play a role in meeting the goals of California's climate change targets and waste reduction (Air Resources Board, 2013). These waste management and energy priorities are not exclusive of broader objectives, as described by the U.S. Forest Service strategies in woody biomass utilization, that have the objective of "sustaining healthy and resilient forests that will survive disturbances and threats including climate change on both public and private forest lands (USFS, 2008)".

The following case analysis identifies opportunities for site specific transport of existing wood chips or densified biomass to processing facilities that include compost, municipal solid waste processing, and potential anaerobic digestion sites as exist in currently active or planned facilities based on the SWISGIS CA Recycling and Waste management data set. This analysis focuses on the University of California, Blodgett Research Forest, as a case example managed in an adaptive framework with multiple objectives, where a range of woody biomass residues may be available in chip, slash and small diameter tree forms. The purpose of this case analysis is to demonstrate potential spheres of operation, transport and distributed decision as applied to geographic costs.

Based on the reference literature, distance calculations were compiled in increments of 100 km to classify the existing waste processing facilities by distance category as outlined in the preceding figures . Figure 2.15. shows a visualization of the distance of all existing waste processing facilities in California to Blodgett. These facilities include a wide range of waste processing and transport operations, compost, recycling, MSW, conveyance, anaerobic digestion and landfilling processes among others. This figure also includes closed and transferred operations. Plants within the 400km threshold include sites as far south as Bakersfield and Kern Counties and as far north as the border with Oregon. Single truck woodchip truck transport at a capacity of 25 tons is estimated at $50-$750 per load.

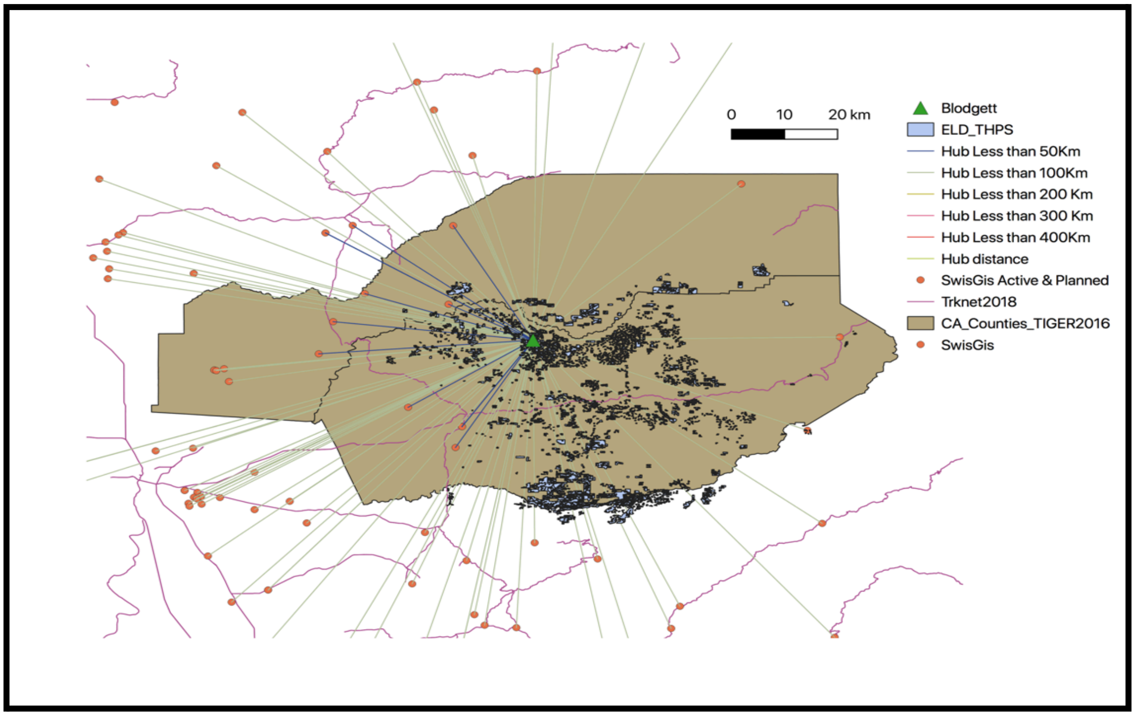
Figure 2.15. Distances from Blodgett Forest Research Station CA processing Sites



This analysis is limited by the extent that Euclidean distance is applied simply without incorporation of road network distances and topography impacts to transport costs. It is expected that application of further network analysis and navigation through the Sierra Nevada's steep terrain would likely add significant additional transport fuels costs and further reduce the distance available for transport. Based on this analysis there are only 10 existing potential feedstock processing sites at a most cost effective <50km scale which would limit labor time most effectively and hence overall project costs and increasing frequency of biomass delivery.

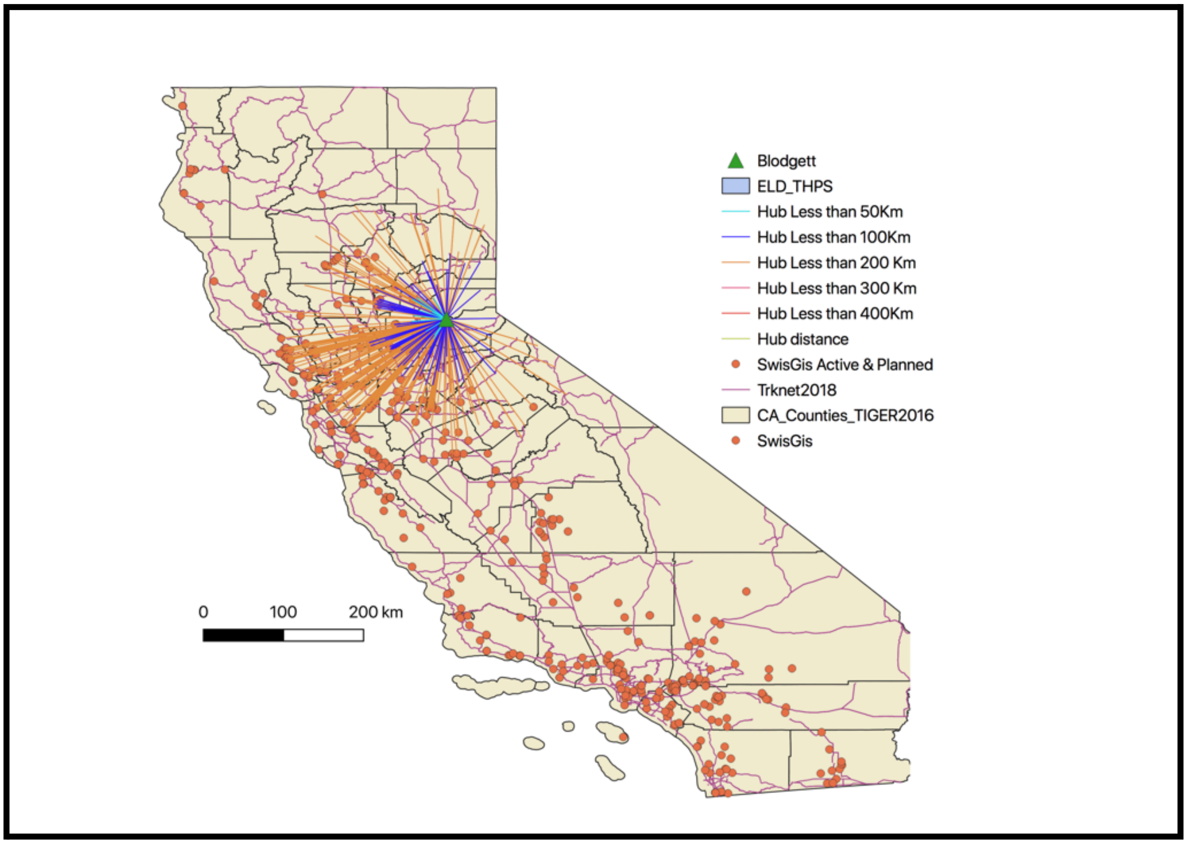
Figure 2.16 further highlights the existing large truck transport network via large highway corridors through the state (identified in legend as Trucknet_2018). The boundaries surrounding El dorado National Forest where Blodgett Research station is located offer a perspective on adjacent boundaries as applied to Nationally managed Forest land and county areas. El Dorado county, to the South includes Forest Service harvest and fuel treatment polygons identified in the legend as ELD_THPS where sited fuel treatment is planned. These polygons similarly to the size of the Blodgett Research Forest may be used as a centroid point to determine relative costs of transport from these locations and prioritize processing plants. Placer county, in the North, has additional forest treatment areas and waste management sites. Of the ten most cost effective potential processing locations only four sites are located within 5km of the highway network. Hence may provide the most fuel transport cost effectiveness. Beyond the direct opportunity for biomass availability and or transport to waste sites, further consideration of Air Quality Control and impact to local communities may be additional factors to consider in subsequent analysis.

Figure 2.16. Blodgett Forest Transport Distances in proximity to Highway Networks



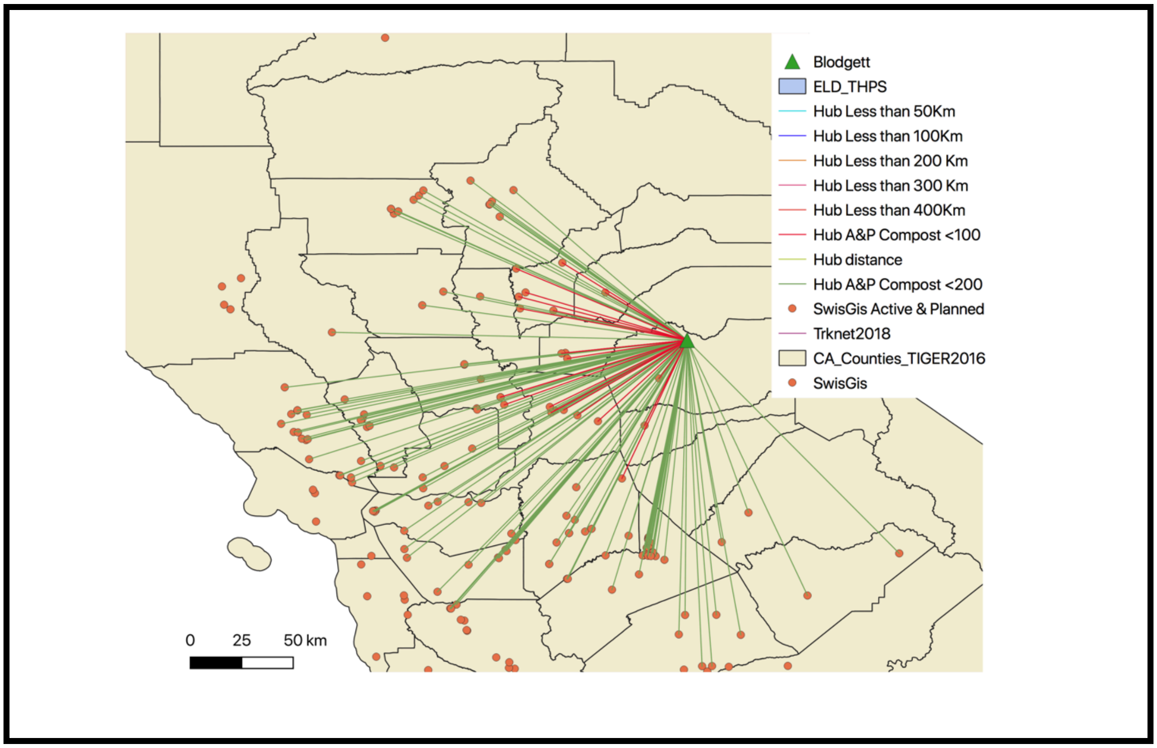
Based on the assumption and referencing, the literature used to estimate costs in the distances of <200, <100 and <50 are used to identify potential for transport to active and planned compost, MSW and co-digestion plants within those parameters. Figure 2.17 identifies all the potential active or planned sites within 200 km. Transport to most areas in the Northern Central Valley and the San Francisco Bay Area are within this zone of analysis which may provide significant opportunity for the integration of wood chips and residues into urban municipal and food waste streams. Based on the estimated costs in previous reference studies the associated fuels cost could likely range between $425 and $375 for the transport of 25 tons of wood chips based on the two reference study estimates. The locations identified in blue (<100 km) are concentrated in the vicinity of the Central Valley and Sierra Foothills in adjacent counties with the extent reaching major cities of Sacramento and Davis. At an estimated cost of $187-$250 these zones may provide a significant opportunity for integration with urban waste streams from this population dense region in the Sacramento and San Joaquin Valleys.

Figure 2.17. Distances from active waste processing sites to Blodgett Research Forest



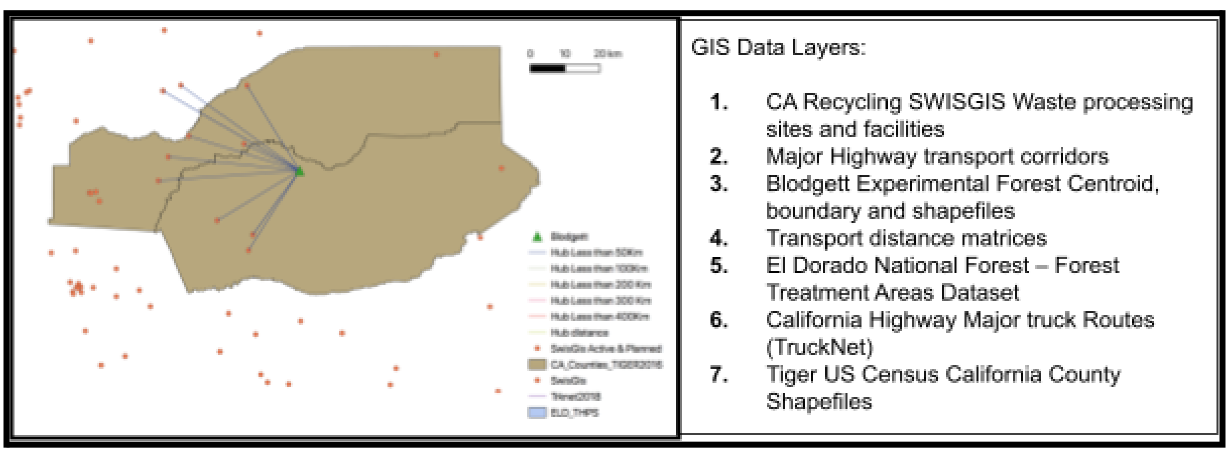
The active and planned compost or municipal solid waste facilities within 200 km and 100km are highlighted in this close up image in Figure 2.18. While in the vicinity of these distances significant opportunity may be available for additional plant specific operations, processing capacity and technical specifications may provide opportunities or limitations to incorporation of the forest residue streams. However, these only include active and planned sites and there may be additional opportunities in the sites in the dataset that have either been recently closed. As this dataset does not include dedicated energy generation or conversion sites but focuses mainly on waste, expanding such an analysis to include additional criteria or ecological restoration sites may lead to expanded resource and processing capacity.

Figure 2.18. Distance to Active and Planned Compost, Municipal Solid Waste and Contained Anaerobic Digestion Facilities in California.



Within the 50km distance the facilities highlighted in Figure 2.19 are estimated to have a cost of $125 to $162 per 25 ton truck load. These sites would likely provide the most significant cost effective opportunity considering minimal distance traveled and topographic features. There are only two dedicated compost facilities within this transport range.

Figure 2.19. Locations of CA recycling and waste management sites within 50Km distance to Blodgett Research station in El Dorado and Placer counties.



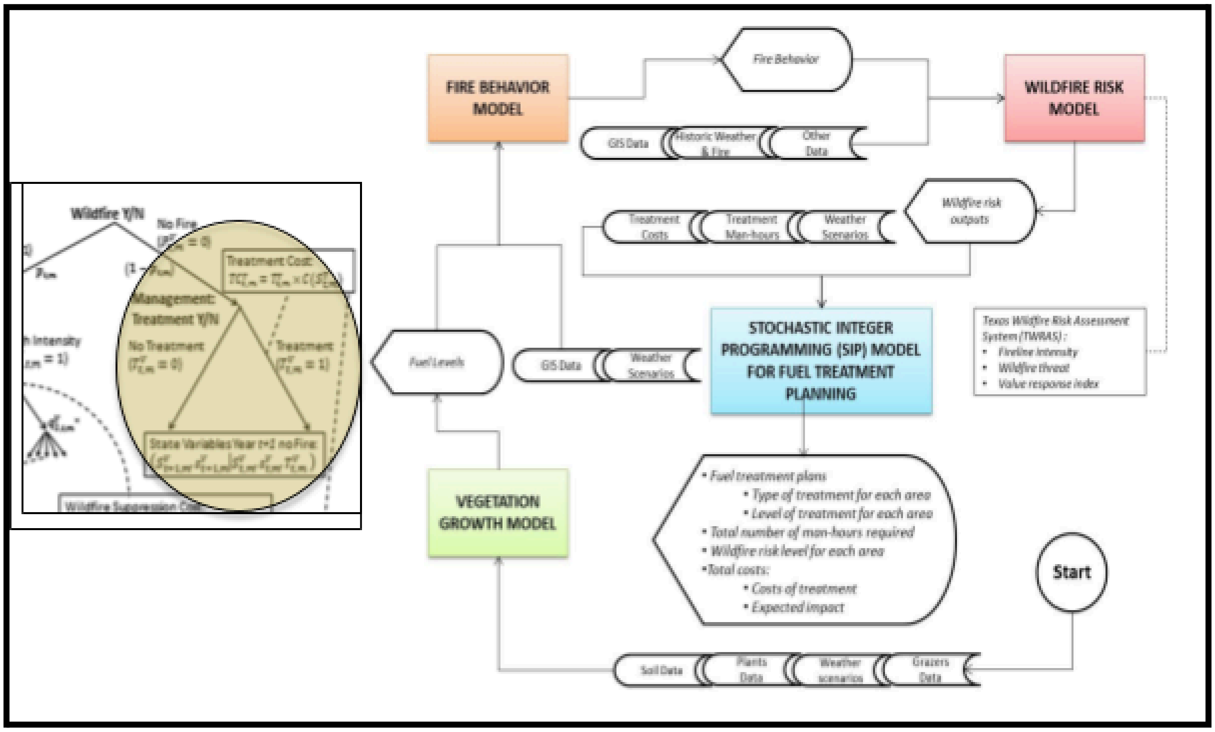
This analysis provides a preliminary approach to consider the effects of biomass cascading or the transport and processing of fuel treatment residues to assist in considering new approaches to cost effectively meet ecological and forest management objectives across multiple criteria of fuel treatment. The challenges facing the management of waste streams, energy infrastructure and land use in the face of climate change provide an opportunity for us to consider more circular economic models and integrated spheres of localized resource management. This discussion frames economic opportunities to consider ecological benefits of varied approaches to biomass resource use, whether for the purpose of forest management and fuels reduction, restoration, bioremediation or the sequestration of carbon and providing additional ecosystem services.

More rigorous life cycle, labor and updated associated equipment costs and sensitivity analysis would be needed to provide a more thorough indication of the site specific costs of transport as provided in this initial GIS analysis. Additionally, the data for transport network, topography and treatment areas could be enhanced including incorporating temporal or seasonal aspects to such an analysis. This initial approach would allow for comparison of site-specific costs from any geographical explicit coordinate and may be further developed to provide prioritization given different site processing parameters, i.e. by type, scale, location to networks or specific infrastructure. As a next step, further consideration into the labor and more robust estimation or reference of costs and life cycle analysis in a spatially explicit context may be the most relevant to further case analysis.

Spheres of Information Flow and Tools for Distributed Decision

Additional modeling complexity exists as we get to higher levels of resolution in the fuel load and vegetation type. For instance the burn severity and burn probability may be significantly impacted by stand structure, composition and canopy structure and type. Figure 2.20. shows a range of simulations from related literature applying treatment approaches with decisions across multiple variables.

Figure 2.20. Spheres of Information Flow and decision

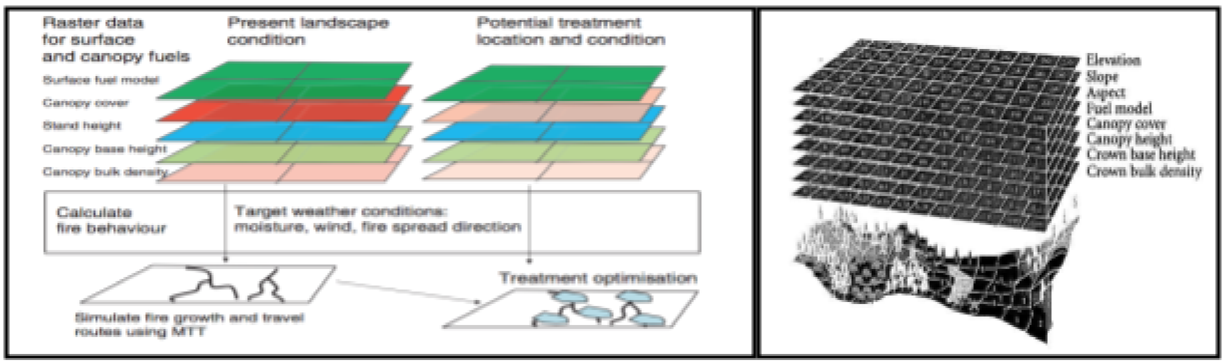


Source: Spies et al. 2017, Kabli, M. et al. (2015)
.
These complex variables and simulations reflect important structural objectives and decision steps that could impact the fuel loads, and future arrangement of fuels across a landscape that iteratively interacts to shape future operational scale. Additionally, multiple levels of policy complexity and dynamic variables not included also create a mosaic and patchwork over space and time impacting fire risk that must also be considered in any optimization method.

This example of such risk-behavior-vegetation and control (treatment/economic models) in figure 2.20. Depicts optimization and decision features where the type, scale, timing and costs and benefit values are identified in the context of staged decision. With a set of areas potentially suitable for placing fuel treatments, the problem is deciding the best place for treatments given future uncertainties and potentially present day management constraints such as labor availability and transport costs. The two-stage model has a set objective of minimizing costs associated with fuel treatments in the first and present stage while also maximizing value over the second stage in ecosystem and other services. The probability of fire and potential burn rate also impact the potential costs in each stage. Such models may consider fuel treatment options as: No treatment, mechanical thinning, prescribed fire and livestock grazing. Critical to the scale of treatment are assumptions and model variables of labor costs and budgetary constraints. Critical are the assumptions of ecosystem and other values in both time periods, to determine if and at what scale treatment occurs (Kabli 2015).

In managing fuel treatment over space and time simulation designs integrate many geographic information system features, spatial data sets, fire behavior and atmospheric models, vegetation models, and risk based methods . In one example, Finney et al. shown in figure 2.21 his team developed an optimization algorithm for use with two separate landscape fuel conditions. In the first (1) Pretreatment fuel conditions exist and in the second, (2) potential treatment placement with vegetation treatment conditions. Fire growth from a single ignition can be contoured to visualize change effects in time intervals. A constraint may be placed on percentage of land to be treated and may be applied to both simple and complex landscape systems, based on model constraints similar to Figure 2.21 below.

Figure 2.21. Information flow across a landscape decision space



Source: Finney et al 2007; Ager et al. 2011

Similar constraints may be able to accommodate differentiated localized landscape objectives or restrictions such as prescribed burning or thinning at the stand-level. As effectiveness of fuel removal may vary by method (i.e. prescribed burn, mechanized treatment), fuel conditions have varying fuel loads in the secondary landscape. Areas that are untreated or untreatable remain as in the first landscape. As units of treatment may impact neighboring units, each treatment size depends on overlap and separation from neighbor units, which will modify and impact successive units.

As treatment prescriptions can be different - reflecting local objectives, field evidence suggests fuel treatment prescriptions achieve reduction in wildfire spread by removing fuels with prescribed fire or low thinning to remove surface fuels and reduce fire severity (Stephens, 2010). The design of a fuel treatment operation can be adapted to consider localized ecological, cultural or social values of the landscape or structures. For instance fire and fuel treatment can be modeled to consider effects on a particular species and the impacts on habitat, foraging range or the related features. The integration of local features, knowledge and operational context is increasingly important and due to specific budget, technical or technology transfer constraints, these features are not often regularly integrated into place specific fire and fuel treatment models (Ager et al. 2011).

Distributed decision spaces are faced with existing circumstances in California's forests, coupled with increasing fire severity, creating complex challenges of treating a vast area in a short time. These conditions have exacerbated the issues associated with California's drought induced tree mortality from pine-beetle infestation and infrastructure interactions such as electrical transmission and distribution lines. Additionally, land management barriers limit the ability for planners to engage in treatment due to restrictions for habitat for wildlife, water buffer zones, further limiting treatable areas by location, size and type (Moghaddas et al 2010)

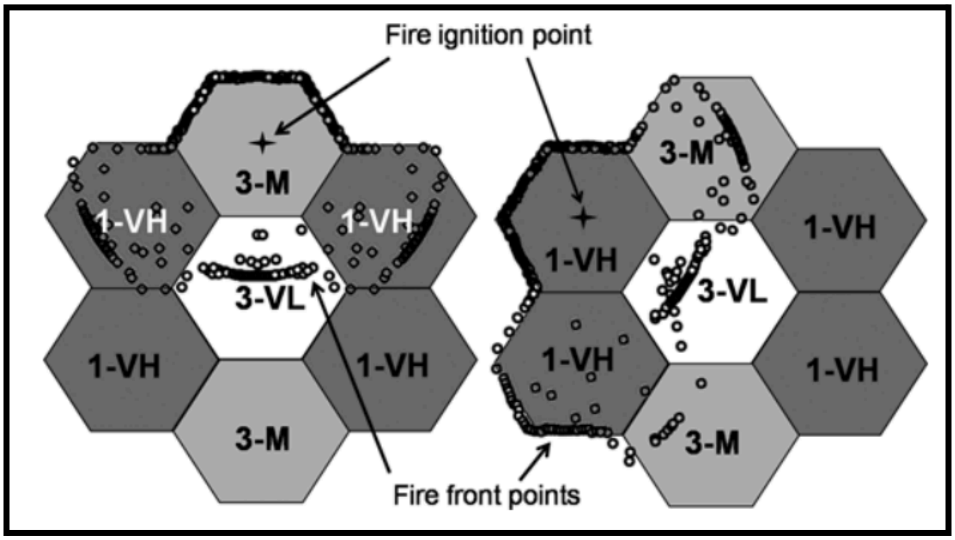
As landscape managers must rely on location specific observation along with geospatial mapping tools and data that describe tree species and other silviculture priorities including estimation of carbon stocks, fuel timber value and harvest volume, multidirectional information flows are essential for local decision on treatment and planning impacts. Both resolution and temporal continuity are important dimensions required for long-term forest management and monitoring, and to establish appropriate predictor variables for fire risk, which may impact fuel treatment planning and placement. Based on the complexities discussed throughout this chapter keeping models simple and adaptable is essential modeling for all scales. Fundamental to this aspect in landscape management is information flow from frequency of physical presence and not relying on potentially outdated or flawed computational data, for decision, yet rather as another information flow to support localized decision.

Spheres of localized distributed decision and complexity: The Where, When and How?

Spatial optimization may be used in coordination with a metric for contiguous, localized or distributed systems, or to calculate distance and rates of change over those distances and minimize or maximize expected values. Some models look at the endogenous risks of a single event and the variables affecting an impact at a singular time step, other dynamic models may be more highly dependent on multiple time steps as shown above, and potential exogenous interactions in response to fire or multiple event time horizons. In the context of decision-making there is a tradeoff in the level of complexity that may be relevant to specific policy decisions. Particularly when decision spaces include varying probability of occurrence or overlapping jurisdictions or nested agencies. To respond to these realities an effort to design simple process based models that may address components of expanding complexity as additive components may provide for better decision tools . For instance, jurisdictional issues may arise that have more decision risk associated with game theoretical applications, than those associated with overly detailed and complex biophysical models. Decisions to respond may be governed more by the responses of administrative authorities in adjacent public lands or private land manager objectives and expected response. These types of coupled or decision making models with multiple criteria may have a significant relevance when negotiating responses on public lands when stakeholders with conservation and biodiversity objectives conflict with forest managers interested in fostering forest resilience, particularly in the context of dynamic landscape level interactions and fire risk over multiple temporal horizons.

A site manager must examine the placement and strategic approach to fuel treatments based on the characteristics of units outside their operational area when planning fuel treatments within their own operational zone. Konoshima et al. 2009 address these questions in the context of a modeling exercise and dynamic operational model in addressing fuel management and timber harvest. The below figure lays out the problem where a fire spread pattern that is initiated in one management unit spreads through adjacent management units at varying rates (Figure 2.22). The spread rate of stands within these units will impact the location of egress across these units, depending on their vegetation density, stand age, type and other biophysical factors, including history of landscape treatment.

Figure 2.22. Fire spread through adjacent forest management units



Source: Konoshima et al. 2009; (Note VH= untreated young stands with high spread rate; M = Untreated Mature with medium spread rate; VL = treated Mature with Low spread rate.)

Such scenarios are nested in distributed decisions as adjacent parcels may impact a fire fuel treatment or harvest decisions for adjacent local managers. In a related economic model, a forest manager is given a two stage ten year decision timeframe with a revenue maximization objective that seeks maximization of harvestable and merchantable timber both in the current period and to ensure expected net present value of future periods. The second state of a two stage dynamic optimization objective function is identified below Figure 2.23a with the following set up.

Figure 2.23a. Two-stage dynamic optimization equation

$$V\left(S_s^2\right) = \left[v\left(S_s^2, D_k^2\right) + \beta \sum_{r=1}^{R} P(S_r^T; S_s^2, D_k^2) L(S_r^T)\right]$$

V= value (S,D = net revenue in period t = 1 or 2)
S = state vectors at time step
P = stochasticity of weather and ignition site features
D = decision vector (fuel treatment and harvesting or other)
β = discount rate
L = terminal condition of land value

Source: Konoshima et al. 2009

Uncertainty about the stochastic features in P also creates uncertainty in the pattern during the first period, but the model also develops an in-depth algorithm to characterize this pattern. In the first stage, the manager makes a decision to harvest or “cut”, while in the second period the decision will be to only “cut” or “grow”. A manager using this model can then develop a spatial optimization for fuel treatments to derive economic benefits in the current period. Additional parameters that may be exogenous to the system, for instance stumpage prices, or treatment cost associated with labor costs or discount rates, dependency on neighboring parcels may also impact decisions to treat and harvest during the first period (Konoshima, 2009.)

These exogenous risks outside of the decision vector “D” may be better understood if we consider broader risk and probability analysis similar to that put forth by Thompson et al in “A Risk based approach to Wildland Fire Budgetary Planning (Thomspon et al 2009)”. As fuels and fire management affect risk, fire occurrence, and behavior when it does occur, the associated costs of suppression activities can be weighed against the potential mitigation costs from treatment activities at relevant scales to determine the expectation of values given certain tradeoffs in treatment type and likely probability of associated fire management costs including accessible labor. In this context the Decision vector is highly dependent on the unknown, managing uncertainty and confidence or “risk tolerance” in adaptive measures.

Throughout this optimization discussion, the type of system, scale of deployment and the resulting impact on stand structure and forest health in a climate and carbon constrained future, pose a range of options and challenges that lead us to consider a system framed by multiple complexities. The scale of potential treatment that may be driven by broad policy objectives may also considerably shift the options for this scenario of localization and fragmentation across landscape treatment.For instance as discussed in Chung et al 2013 and as visualized below (Figure 2.23b.), the cumulative scale of treatment and economies of scale (e.g. costs) associated over specific time periods will significantly impact the type of technology, deployment timeframe and approach to fuel treatments employed. While deploying large scale mechanized treatments may benefit a supply scenario and bring technology system costs down, the potential to scale the technology, solutions and systems over a sustainable time frame would come into question. Hence, performance at scale to meet forest resilience priorities may be an additional barrier.

Figure 2.23b. Considering scale and sustainability of treatment type over long time periods

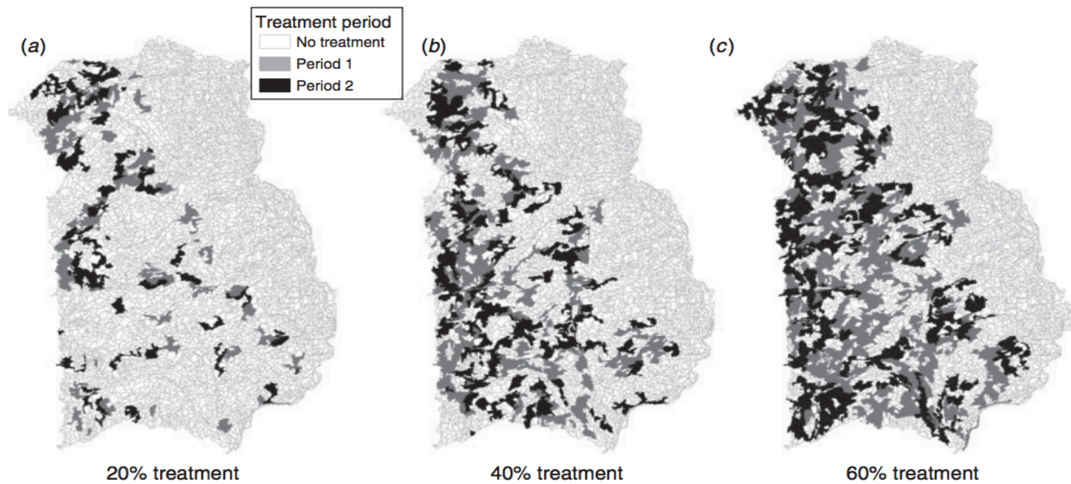


Fig. 5. Optimised fuel treatment locations and implementation time periods under each treatment intensity.

Source: Chung et al. 2013

A more process based approach may be more effective in a distributed decision space to simplify the complexity over these other more complex spatial models with iterative decision that inevitably requires labor regardless of the number and quality of the simulation run. More process based models may be workable or practical for local managers and operations staff. Nonetheless, designing a process that can integrate multiple layers of treatment priorities over large spaces and adaptable to local conditions and distributed decisions may prove to be a complex task, given the current state of the science and policy nexus. The trade-offs between management options, system stability may look significantly different over the short and long term. Much of the recent forest management literature has discussed the focus on building forest resilience and resistant systems that will be able to sustain some manner of steady state or global stability over the longer period influenced by climate change and human pressures of land use.

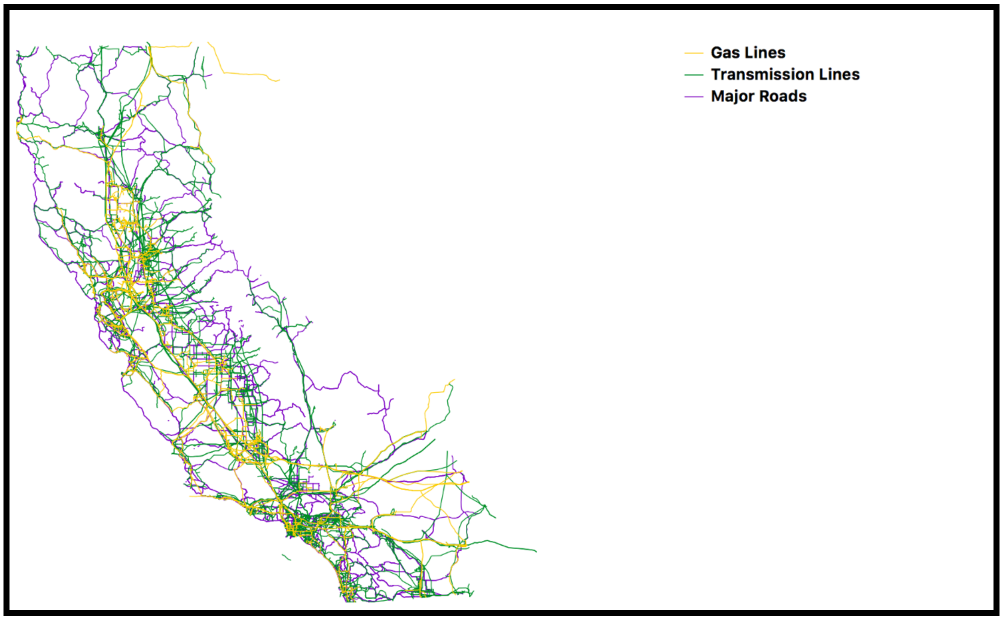
As fuel treatments may be increasingly used in the American West, and specifically in California, as a tool to mitigate catastrophic wildfire, these assessments and the findings developed from easily reproducible process models will likely be increasingly important. A process that repetitively asks where, when and how to deploy treatment, will likely increase options, heterogeneity in approaches and outcomes over the short-term and potentially lead to increasing heterogeneity in outcome and implementation if the policy prescriptions are implemented with local decision-makers, manager, silviculturists and the local labor on the ground. In considering these values at risk, and operational feasibility across many objectives, we must also consider the evolving human decision-making component that is essential to put these scientific methods into practice. To deal with complexity, we must remember the adage that models need to be kept simple, but no simpler than necessary, as we bring multiple perspectives and dimensions to the table.

2.5 Case Study: Internalizing Fire with Sustainable Energy and Localized Futures in California

California is facing critical complex system challenges in the context of increasing frequency and scale of wildfire, water stress and inequity of burdens of environmental impacts upon what the California Office of Health Hazard Assessment (OEHHA) defined as “disadvantaged communities” based on a criteria developed known as the CALEnviroScreen (OEHHA Website 2017). The combination of environmental indicators including air pollution, water access, water quality and potential fire risk may exacerbate existing income disparities and access to service inequities. Based on these and additional criteria, the State of California, through the California Energy Commission’s Electric Power Investment Charge (EPIC) program commissioned a project of research through the University of California Berkeley to engage communities in the San Joaquin Valley in Central California in the design of Sustainable Energy and Localized Futures.

This case study highlights some of the work developed in that project from 2018 until 2020. Figure 2.24. highlights data used in the examination of access, proximity and potential impact to energy systems and fire disruptions across the State. Additional data features were used in the project, however, this case analysis focuses on the interaction of select unincorporated communities and potential risks and opportunities from wildfire, wildfire mitigation and vegetation management.

Figure 2.24. California’s major network infrastructure related to Internalizing Fire



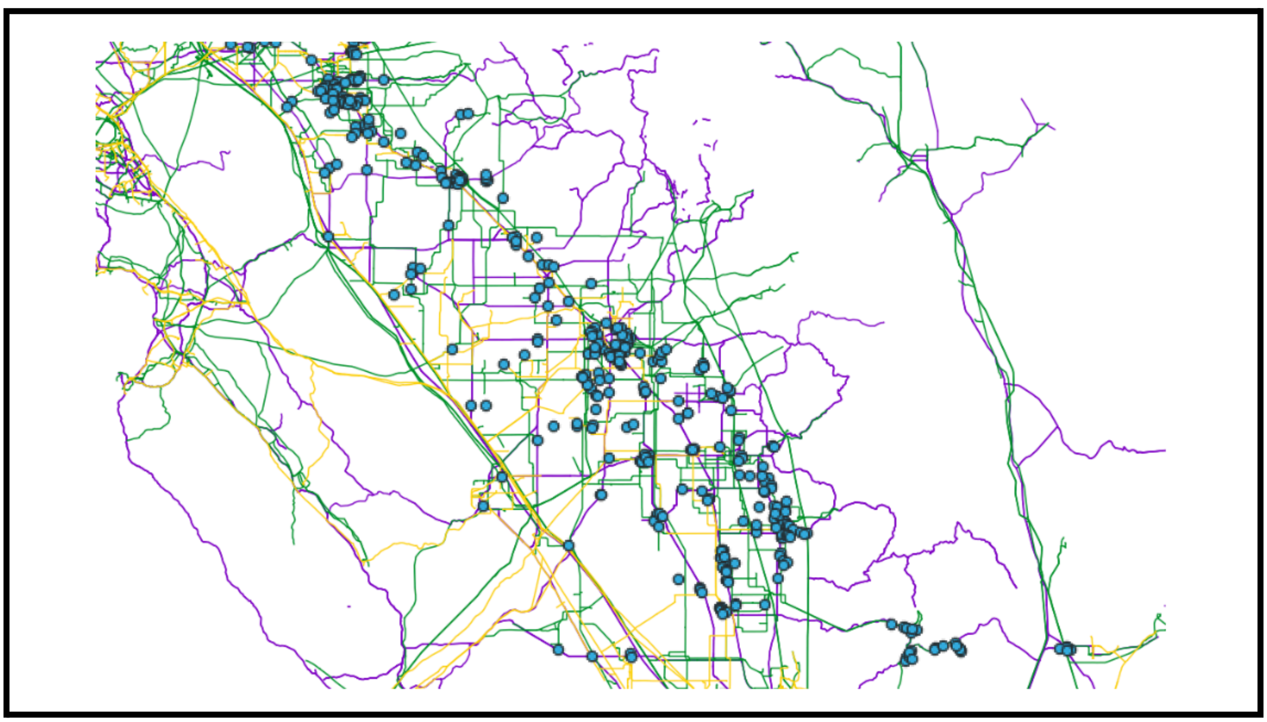
As part of the Sustainable Energy and Localized Futures (SELF) project which included regular site visits to "disadvantaged communities" and observation of community meetings and State hearings in the provisioning of energy services, a website was created that focused on broadening participation for the use of individualized geographic information systems developed and published online in 2020 at this URL https://sites.google.com/berkeley.edu/self-indi-gis/self-data-and-visualization.

This site, data and visualizations were developed with a focus on unincorporated areas with the assistance of a community based organization in Visalia, Fresno and Tulare counties, known as Self-Help Enterprises. This organization since the Post World War II period has historically provided housing and services to diverse farm working and rural communities in the region. The development of this selection of visualizations highlights some geographic features and boundary areas related to minimizing risks to these unincorporated communities posed by fire and energy system challenges.

One of the objectives of the study was to consider selection criteria for potential pilot energy system projects and an engaged community participation at the local level to participate in a simple multi-criteria decision process that could meet the State's environmental and social goals as determined by the State Legislature. While this study and related work was initiated in 2017, the increase of catastrophic fire events and related impacts to air pollution and human health were significantly increased and experienced across the populations living and working in the San Joaquin Valley and neighboring areas. These communities have historically suffered from multiple sources of air and water pollution. A key contribution from this work was to develop accessible geographic information systems tools and data to better understand the localized impacts and opportunities in mitigating these multi-criteria stressors on disadvantaged communities as defined by the State. One deliverable of this project was the development of a SELF Proximity Analysis Housing Database (PAHD) to provide open source data on the proximity of existing communities and populations to infrastructure and ecological features.

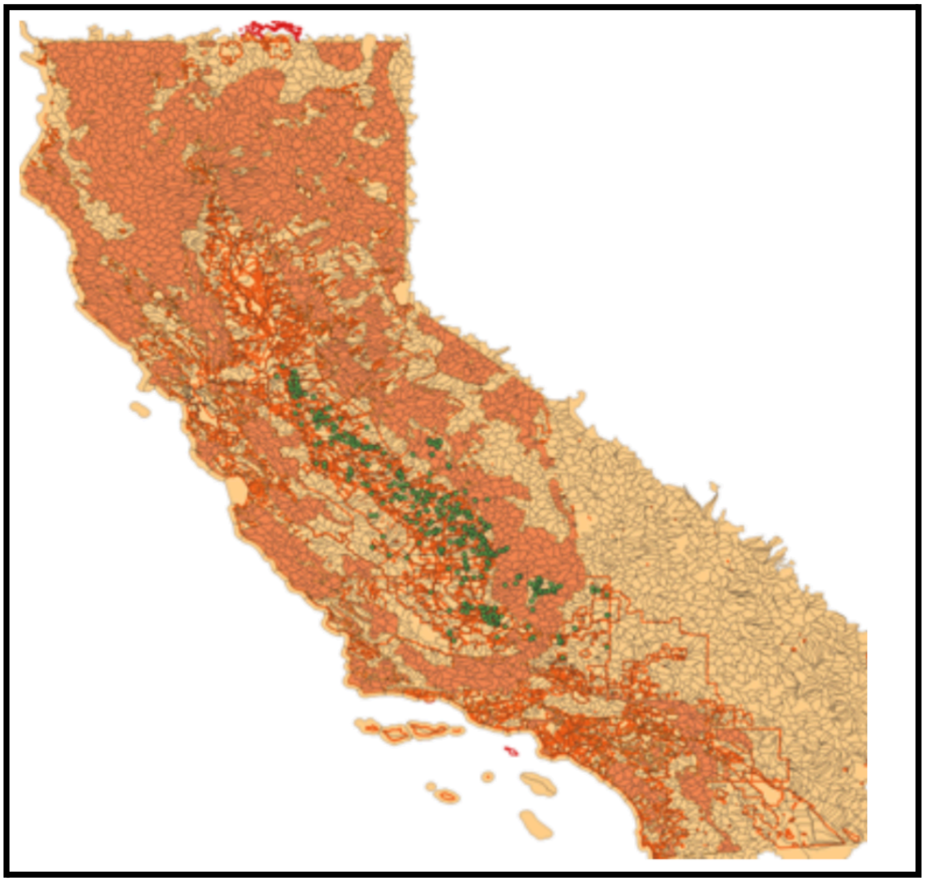
This PAHD database was developed to provide an understanding of methods in ranking the proximity of unincorporated communities to basic regional infrastructure and services. Using these and other features a select analysis of proximity of high risk zones based on publicly available high risk zones was conducted. This data is built on a set of 450 points representing unincorporated communities from the UC Davis Center for Regional Change that replicated the PolicyLink Unincorporated Communities dataset (revised from 2013). These data points are classified as disadvantaged and unincorporated communities and also referred to in the literature as DUCs. The UC Davis data also provides additional insight about proximity to community water systems and other infrastructure as, incorporated into a network overlay of major infrastructure, provides a visualization of density of unincorporated communities in the region (Figure 2.25).

Figure 2.25. Disadvantaged Unincorporated Communities in the San Joaquin Valley with network infrastructure overlay.



Based on this and other data, using open source QGIS software, a California Public Utilities Commission tree mortality dataset was incorporated to provide an indication of potential fire hazard or fuel treatment opportunities within proximity to these communities. Vector data was used to create a 10 mile radius as a transportation buffer to approximate an minimal economically viable distance for frequency of daily commuting in a local economic and farm and forestry labor perspective, based on relative transportation costs for farm labor and forest products transport as discussed in earlier sections. This buffer was incorporated with tree mortality geographic shapefiles data to provide boundary and location analysis of CPUC determined high tree mortality hazard risk sites as an approximation for economically treatable and accessible vegetation. A statewide visualization of this data and unincorporated communities in the study area of the San joaquin Valley is visualized in Figure 2.26.

Figure 2.26. California vegetation management and fire risk zone data overlaid with disadvantaged and unincorporated communities in the San Joaquin Valley.



Based on the data attributes, an estimated total population that may be affected across these adaptive "fire watershed" communities can be observed and compared to Cal Enviroscreen data across a range of indicators. As shown in figure 2.27, the buffer analysis identifies 73 communities from the disadvantaged unincorporated communities data that are within the ten miles of the fire risk zones with high vegetation and tree mortality risk in the San Joaquin Valley Air Quality basin designation. Of these 73 communities from this data set 56 exist in designated Groundwater Sustainability Areas, which may provide a regional coordinating entity to provide water system benefits of the vegetation management and fire risk reduction efforts within those specific agency structures, or at least consider tradeoffs related to water systems in fire preparedness and other landscape management activities.

Figure 2.27. Identification of Fire Watershed Communities through a buffer analysis

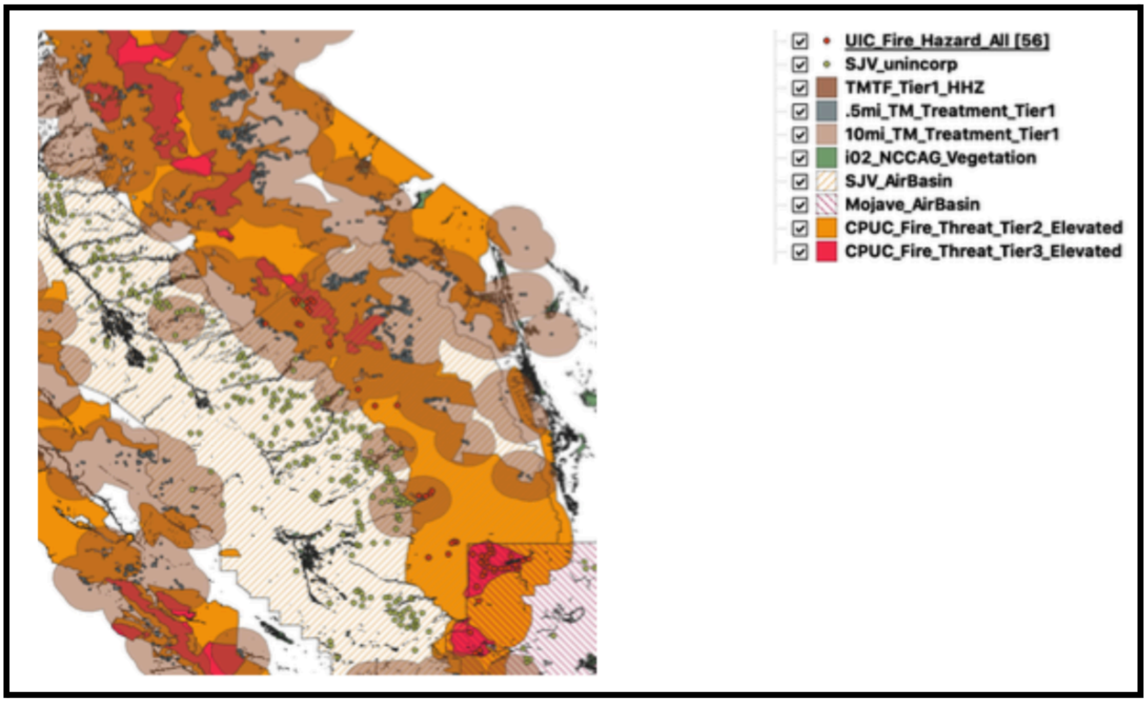
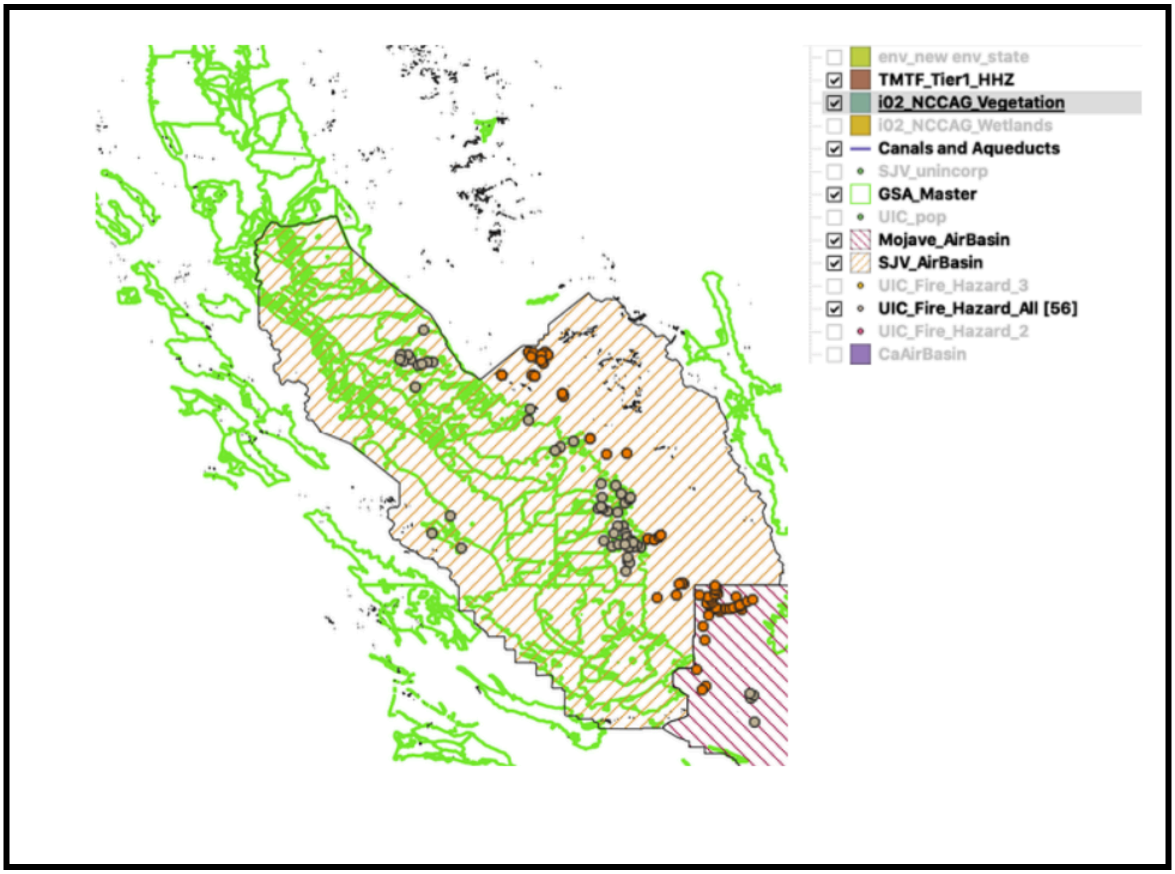


Figure 2.27 also demonstrates more clearly the delineation between air pollution basin and groundwater sustainability agencies across the study region including the boundary between the San Joaquin Valley and Mojave Air Basin coordination region. Cross boundary migration of water contamination and air pollution are increasing concerns as the increase in fire events and impacts move across regions and administrative authorities.

Figure 2.28. Air Basin administrative boundaries and groundwater sustainability agencies across the study region of Fire Watershed Communities.



Based on this analysis, the most populated cluster of unincorporated communities within a buffered vegetation treatment area of ten miles from high tree mortality zones and single GSA boundary can be observed with the 10 communities concentrated within the Merced Irrigation-Urban Groundwater Sustainability Agency zone. This case analysis provides an example of opportunities to prioritize or develop location specific approaches to fire risk reduction, labor service application and estimation of potential populations impacted by specific fire policies and associated resource allocation and ecological risks in the study region.

Evolving conditions in response to the COVID-19 pandemic have further emphasized a focus on distance calculations applied to issues of proximity, accessibility, and reliability to utility services, housing and place of work and access to public services, and the reliability of infrastructure services and community health services. The selection of existing data developed in these analysis of proximity along with indicators from California's Office of Health Hazard Assessment (OEHHA) Cal EnviroScreen provide an open reference for diverse communities including those that have historically lacked inclusion into planning processes.

This data and related analysis and discussion of a participatory practice in planning may help to better estimate the scale and approaches in “internalizing fire” in an academic, policy, community and individualized setting. Communities that have been underserved or where barriers exist (demographic, administrative and institutional) that may limit the effect of policy solutions in addressing community needs and equity concerns in the context of the State of California Agency may benefit from such iterative analysis with open source tools and open data.

Corresponding project resources have been designed with a view towards meeting needs of the above stated communities, and providing tools for locally based community organizations to assist in the development and visualization that can foster greater dialogue, inclusion and understanding within an equitable and resilient resource planning framework. The data used in this process has been aggregated to community level and anonymized so that only previously published community designations and administrative boundaries are considered.

2.6 An Adaptive Fire Framework in Labor over Land: Introducing the LOL Model

As California and neighboring regions experience extreme weather, drought, fire, floods and the effects of strained public utilities across regional resource networks - an economic geographic approach contextualizing the challenge and scale of land stewardship operations in the 21st century requires a new examination of historic connections between Land and Life as discussed in chapter one and a shift from business as usual paths to future options.

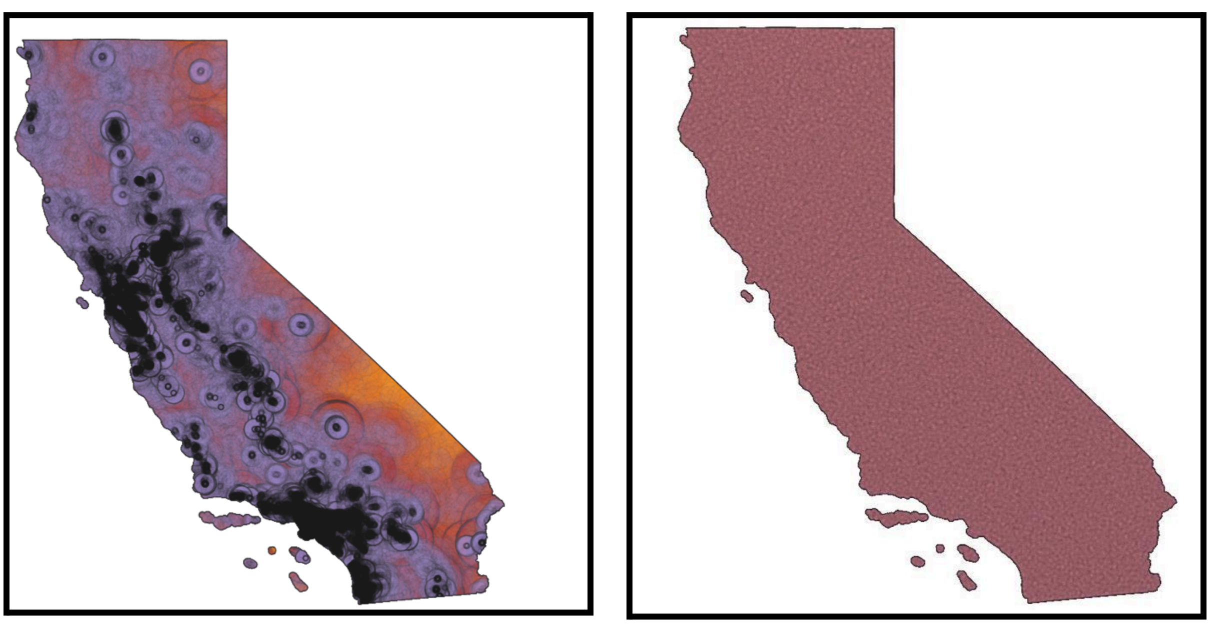
This analysis and proposed Labor over Land model builds from the ideas discussed earlier in this chapter to practical responses to the recent glut of catastrophic fire and interactions in power systems, electrical grid network risks and iterative landscape vegetation management operations to address the question: “Where and in what frequency can Californians address complex environmental risks amid landscape and labor supply resiliency - in the face of fire?” This case engages broad spatial and geographic challenges posed by ‘circles of labor’ over landscapes in the fire prone California ecosystem to frame a discussion of globally coupled human and natural systems’ challenges. The analysis proposes the need for a new model of economic, transport and labor in operations and labor over land - in the face of fire - based on learning from historic practice and using today’s best available private transport system technologies to fit a “circular economy” and “sustainable livelihoods” framework.

Recent analysis and literature in forest and wildland fire management discuss the interactions and uncertainty of managing for climate effects, and the pressures of urban spaces, populations and shifting ecological systems as discussed throughout this dissertation. However, attempts to address these challenges broadly propose static and short-term responses to mitigate harms in a business as usual scenario, which inadequately addresses fundamental challenges in the design and layout of the complex systemic dynamics and the shortfalls of some market mechanisms proposed to date as discussed in this chapter two. These hazards are linked to decades of neglected landscape scale management and interacting effects of population pressures, fire suppression, displacement of domestic labor on the land and non-localized decisions and the subsequent ecological response.

In a model proposed here of enabling daily cyclical or circular responses to 'labor over land,' a more dynamic approach to consider regional models of frequency of presence with a simple algorithmic model applied to open source geographic information systems (GIS) is used to elaborate critical gaps in sustainable and circular economy dialogues in California and globally. This simple economic and GIS model evaluates the spatial and coupled cost factors based on historic context, best available technologies, and related cost assumptions as discussed in chapters one and two. This approach highlights contemporary critical assumptions about population and the limits of networked systems, the stability of flow in transport modes and infrastructure. Labor and transport decisions are brought into focus by recent extreme weather events and overlapping public health and economic crises, affecting the distribution of population, where people live, and how they work.

As discussed earlier, if we accept that a high frequency of observations and daily operations are required to address the shifting complexities on the landscape for local decisions on landscape management, biomass transport and long-term land stewardship (i.e. iterative prescribed fire and mechanized fuel reduction and processing) we must consider a practical labor over land model. In this analysis a Business as Usual (BAU) case, transport and spatial results are compared to theoretical limits of labor distribution in an iterative Labor Over Land (LOL) model Figure 2.29. A critical analysis under multiple transport scenarios is developed based on a suite of transport modes and historic assumptions of private truck transport discussed earlier among other cost data (including electric vehicle, internal combustion vehicle, motorized bike, conventional bike and walking) providing a spatially explicit area of labor coverage, and travel costs to consider value tradeoffs.

Figure 2.29. Preliminary results in Open Source GIS based BAU LOL Model.



A. BAU Transport Mobility distribution B. Theoretical LOL Mobility distribution

This model suggests two extreme scenarios as a preliminary theoretical framing to what will realistically result in a more distributed population across the State of California than we see today in the BAU scenario as housing, cost of living, remote work life and other pressures related to "values on the land" move people into areas of less density. Likewise a random distribution across the State as reproduced in scenario B would also be unlikely. Somewhere between these two is more practical as more people experiment with increased mobility, off grid renewable energy lifestyles, and a range of innovative community structures.

Based on these distributed population scenarios and daily transportation options available today as best technologies based on the assumptions listed in Figure 2.30. Individuals are able to transits for daily work onsite and return to their original destination of housing either in the BAU case which uses a randomized subset of the population available for work "in the field" based on a random distribution of points in census tract designated areas and in a theoretical case of the same number of participants spread randomly across California.

Figure 2.30. Labor over Land: LOL Transport and Flow assumptions for both scenarios

Business as usual	Labor over land
Key scenario assumptions	
• Existing population distribution • Standard transport constraints • 24 frequency of home return • Single time step	• Theoretical randomized population distribution • Standard transport constraints • 24 frequency of home return • Single time step

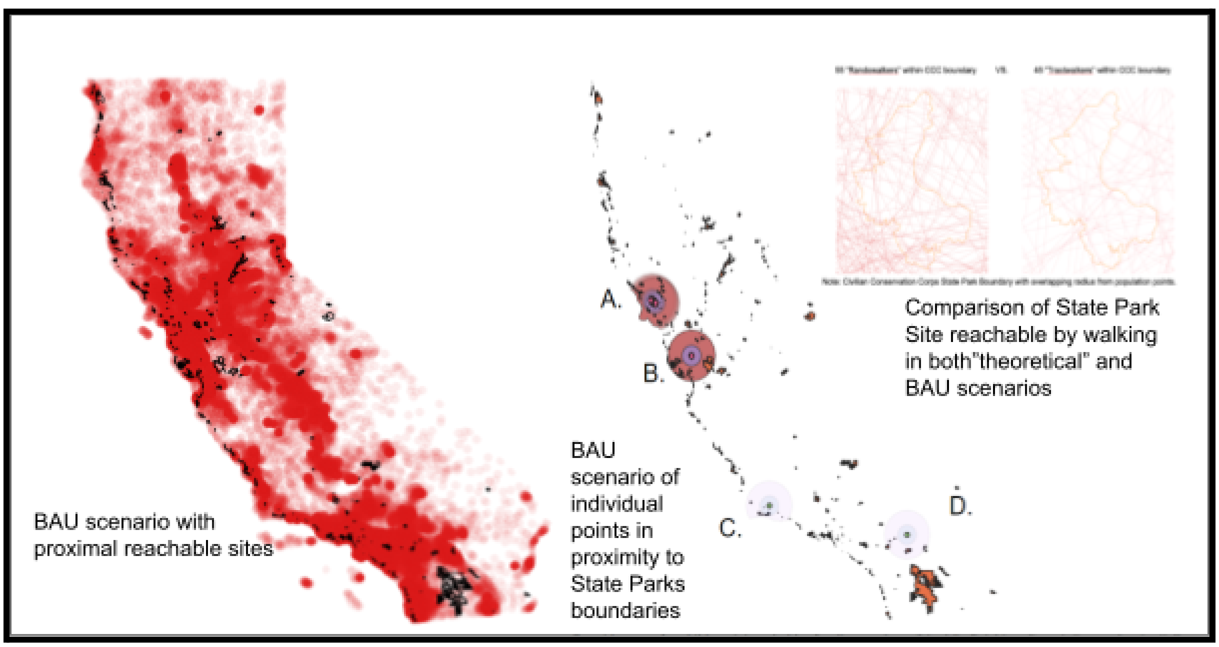
References: Isard (1960) Methods of Regional Analysis; Sauer (1963) Land and Life; *Walter Y. Oi and Arthur P. Hurter (1967) The Economics of Private Truck Transport*

Transport Mode	Euclidean distance (radial) per diem	Reference/source
Walking	10 miles	Land and Life, Sauer; Ethnography
Bike	20 miles	Ethnographic Fieldwork
Motorized Indiv. transport (motor/e-bike)	40 miles	Operational Knowledge
Internal combustion engine	50 miles	Economics of Private Transport; Ethnography; Forest Op. Knowledge
Electric vehicle	50 miles	Average Industry range California
4 Person carpool truck	50 miles	Economics of private truck transport

Note: Estimated distances are for one way travel.

Based on initial results from a simple model run in the BAU case we can see the buffered zones in the BAU case overlapped with State Parks boundaries Figure 2.31. In the below results based on daily commute times, potentially reachable field sites for fuel treatments in State Parks boundaries can be observed. On the right we can see one example of walkability to the State Parks Civilian Conservation Camp in Central California where potential participants within walking distance number 55 participants in a random distribution case as compared to 45 participants in the business as usual case.

Figure 2.31. Preliminary model results in a BAU and Theoretical distribution



The Labor over Land (LOL) model may be applied in a range of practical applications for State funded or private and other publicly funded programs to identify opportunities, costs and potential participation of California residents within proximity to field sites to volunteer[1], work, manage, recreate and make decisions on the landscape with increased frequency. Additionally, this simple model may be adapted and applied to discuss equity in access to public amenities, new housing developments and other land use decisions. In the context of prescribed fire and fuel treatments, funding agencies for related activities may apply the model to estimate potential budget and personnel available for ongoing work and fuel treatment decisions across scales on California's landscapes. A more specific application of this model is further discussed in chapter three of this dissertation in the context of restoring Manzanita habitats.

2.7 Tipping the Scales: Incentivizing restoration (Investing in Biodiversity) and local knowledge

The management of structure within a forested land system, i.e. the spatial extent of a forest edge and the fragmentation of forest, agriculture and contiguous habitats are important topics in the ongoing monitoring and stewardship of land systems globally (Nowak, 2017, The Edge., Finney, 2007, Fule, Bettinger, Stephens et al.) This sets the stage for related geographic and spatial economic questions of forest growth, rates of change amid shifting boundaries and the operational processes of restoration and long term adaptive stewardship.

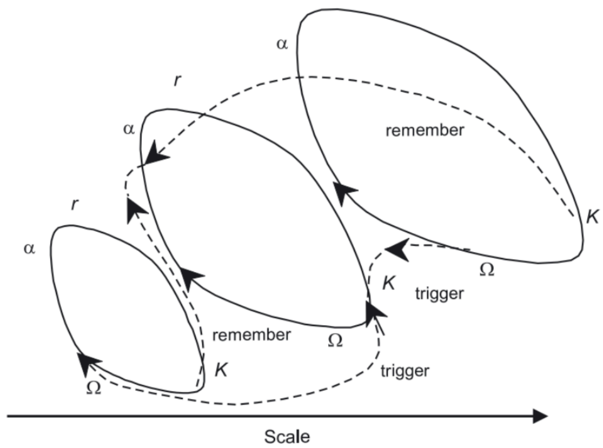
In decision processes in the face of fire, semi-permeable boundaries of vegetation structure, riparian, subterranean and atmospheric systems exist in dynamic interactions as a complex adaptive system. An improved understanding of this decision space and how the interrelated human behavior of interacting agents affects the stability of the vegetation and fuel systems can improve the interpretation of information, systems science and the management of these and neighboring landscapes.

The boundaries of human decision including the concepts of situational awareness and bounded rationality and associated learning rates are also semipermeable due to the way knowledge and information are processed dynamically by individuals, between neighbors and across generations that also are impacted by prior knowledge, memory and adaptive processes. These processes operate across temporal (i.e. frequency), spatial and local variation that can be constrained by the nested systems that may govern or interact with culture, social and institutional signals. Janssen and Ostrom discuss these interacting multi-scalar knowledge systems in the context of triggering events and institutional memory as shown in (Figure 2.32).

Figure 2.32. Adaptive cycles across scales, memory and institutional knowledge

[1] The California act of March 18, 1905 required the State forester to establish districts and appoint citizens as voluntary fire wardens, who might be paid by counties or private persons or corporations. The State Forester and all fire wardens were empowered to arrest without warrant offenders against the forest law. They were authorized to summon all citizens between sixteen and fifty years for not over five days service annually (Kinney, J. P., (1917) The Development of Forest Law in America. John Wiley and Sons. Inc.

Internalizing Fire across Scales adapted from Jannsen and Ostrom, 2005



A role of cultural memory and flexible response (SELF + FLEX)

Fire (frequency), Learning from Experience and Exchange

Figure 2. *The Adaptive Cycle at Three Scales*

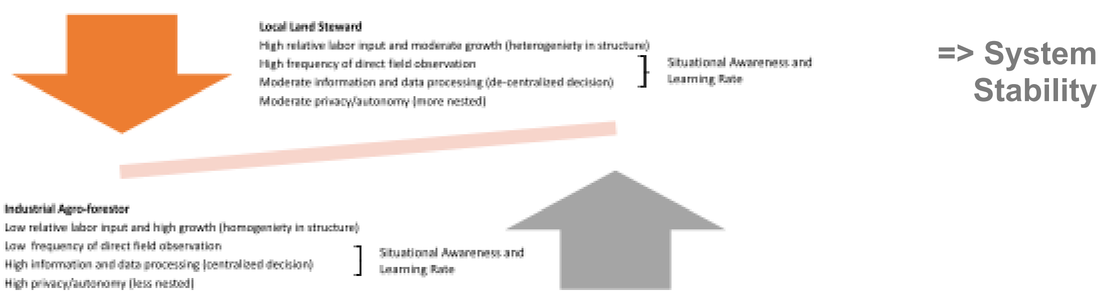
Finally, these nested systems or social institutions may operate autocratically or in a cooperative, competitive or overlapping environment that impacts the human decision space, but may also be constrained by the biophysical system, which may favor the degree to which the systems are nested [i.e. more nested (distributed decision = fragmented in space) or less nested (centralized decision)] with direct effect on information flow, institutional memory and perceived spatial scale of control, production and fragmentation, and the agent's decision and knowledge base under fire risk.

In the context of this description of multi-scalar boundaries in the face of fire risk, many factors influence each other in a complex system of interdependent variables. To simplify and provide some grounding for this problem in a fire context, these boundaries are specifically considered across four variables 1) the degree to which the vegetation structure and NPP vary from heterogenous to homogenous systems; 2) the frequency of direct field observation; 3) degree of information and data processing of the agent (individual actor) characterized by centralized or decentralized systems; 4) the degree of privacy or autonomy, in which the decisions are restricted by oversight, external monitoring and verification, that determine the degree that the agent is part of a nested or overlapping system. While all of these variables may impact the situational awareness and learning rate of the agent, the frequency of direct observation and degree of centralization are the primary factors considered in direct correlation to the degree of local variation and neighbor interactions or degree of nestedness.

These factors are key to the development of an economic information model that may be a practical tool in policy guidance and frames of the decision process from the perspective of a Local Land Stewards Tradeoff as highlighted in figure 2.33. In this context the individual agent or variation of neighboring agents along a nested system seek an agreed payoff of vegetation structural stability (i.e. Net primary productivity of biomass/carbon loading) when faced with fire risk. Here, a basic assumption will need to be agreed as an indicator of a healthy local forest system with a long-term and stable ecological community.

A key component to determining these values in what resembles a multi-criteria optimization model is the weighting of these associated values which may be done initially in a binary (e.g. yes (1), no (0)) formulation or by varying degrees related to the weighting of variables. These weightings are derived from a set of qualitative and quantitative methods further outlined that consider data from historical cases and existing empirical studies of vegetation structure, spatial and fire ecology, as well as social science and applied research that examines knowledge systems, technology and social learning rates, and information, cognitive and decision architectures.

Figure 2.33. The Local Land Stewards Central Payoff = System Stability



Incentivizing restoration, forest and soil health across landscapes

The seasonality, temporal and geographical distribution of biomass transport including “waste streams” and forest residues can have significant implications for urban and rural areas, hence potential optimality in considering application for soil or energy applications that may vary spatially and temporally. Additionally, the chemical and physical composition of the type of biomass residue that may be integrated or introduced for conversion creates important parameters for consideration in end use and objective. These types of “green wastes” can be used in the context of composting, co-digestion, or energy production, however the effects of the nutrient composition that affect carbon (C), nitrogen (N), phosphorous (P) and potassium (K) has an impact on the prioritization of these values in the context of broader economic and energy applications. The land application and choices in conversion of these nutrients can significantly impact land and soil productivity and long term ecological stability (Biswell 1956, Vandakasteele, B. 2016).

Soil health as a driver for biodiversity and restoration

One application that may affect the costs of transport is biochar of woody biomass residues, which affects the moisture content and density of material transport. Biochar, produced through pyrolysis of carbon-rich plant and animal residues under low oxygen and high temperature conditions, when used as an additive can increase soil carbon sequestration and improve soil quality. Such amendments may have an impact on the bioavailability of contaminants to microbial communities, plants, earthworms and other soil organisms. Biochars effects on adsorption and desorption on leaching of pesticides is an area of current research with demonstrable effects for living organisms (Khorram, 2016).

The application of biochar can enhance and affect crop yields when used as a component of compost or soil amendment through effects on moisture, provision of organic carbon, hydrogen to organic carbon ratio, soil stability, ash content amelioration, total nitrogen, liming agency, electrical conductivity, particle size distribution. The application of biochar in other uses such as animal feed and varied approaches to land remediation and carbon sequestration (Timmons, 2017) is also en emerging area of research. Primarily, biochar may be spread in forest and agriculture lands to improve and adjust soil qualities. The addition of biochar requires an understanding of the existing soil chemistry, moisture content and seasonality based on soil analysis and vegetation and forest type, and potentially stand structure and tree stand dynamics. The use of woody biomass for biofuel may help meet energy and climate objectives, however, biomass removal may deplete soil nutrients with temporally specific impacts on tree growth over the short and long-term. Temperature and soil moisture may be highly affected by biochar and seasonal variation.

Across the many objectives and management priorities, the discussion in this chapter points to the varied biomass management strategies that may be employed to maintain resilient sustained forestry practice to minimize wildfire risk while incorporating some residues for use in bioenergy, composting or biochar production and other restoration processes. Alternatively the effects of prescribed fire may provide similar nutrient cycling benefits at a fraction of the cost (Biswell, Helms). The type and scale of silvicultural procedure and the fate of slash or wood residues may be highly dependent on objectives of regeneration at the site, hence consideration of allowing slash to reside, allowing residue removal or prescribed burning to remove fuels may be impacted by a range of ecological and management objectives. The approaches and scale of harvest, treatment and location of residues will have significant impact on the loading and transport costs at scale in any landscape restoration effort.

2.8 Resilience in the Face of Fire: Finding a Politics of Practice with Labor over Land

California's forests and human interface areas face unprecedented threats from shifting fuel loads, fire severity, fire regime and urban proximity. In October 2017, Northern

California experienced unprecedented fires, the most damaging in state history, with hundreds of thousands of hectares burned, over 6,000 structures destroyed and significant loss of life, followed by a similar scale of events in Southern California in December and in even larger catastrophic fires in the following years. The challenges in managing these fire risks, amid uncertainty from shifting climate, precipitation and land use require increased systems analysis of the science, but also socio-cultural conditions, and particularly labor, of how fire is managed in California, and its related costs with learning and shared features of co-creation across similar Mediterranean and arid regions (e.g. Southern France, Spain, Portugal, Australia, South Africa, etc.)

The frequency of severe forest fires is expected to increase with extreme weather events and climate change (e.g. prolonged drought), and shifting vegetation and fuel loads (Westerling, 2008). Emerging strategies for managing ecosystem resilience and mitigating risks to human communities provide hope, although greater recognition and understanding of inherent variation and links is crucial (Moritz et al. 2014.). Further investigation and systems analysis of risk management and land-use and resource management policies in such systems is critical in identifying contemporary approaches in resilience and management. Foundationally, the interaction between forest management, mechanical, other fuels treatments, electricity infrastructure and urban settlements provide ecological and economic limits to the scale, distribution, risk probability and costs of managing both engineered systems and ecological resilience.

Increasing energy system transformation, coupled with increasing population and housing pressures in rural and urban interaction with the fuels that impact wildfire frequency and severity – require management of our engineered and ecological systems to support greater “integrated resilience” or ecological security. Monitoring the anthropogenic impact of historic and modern fire regimes is critical to understanding how to learn from, use and coexist with fire. In some regions of the world fire has been and continues to be integrated into daily life. In others, the focus on suppression and extinguishing fires from natural or working lands has led to multiple challenges and wide ecosystem and social impacts.

This discussion of related models, information flow and decision with GIS data contributes to the integration of economic and ecological models through the interdisciplinary fields of economic geography and fire ecology in complex adaptive systems. The transdisciplinary engagement with Ecology, Economics and Energy Systems Analysis to assess ecological impacts in the context of Internalizing Fire at what cost and scale brings the focus to process based local actions that have been at the foundations of our fire cycles for millennia. The Social costs are integrated with the costs to natural systems resilience in this frame and include fire management regimes and forest management incentives and systems at the edge of our agriculture and food systems security.

Interactions between human presence, urban footprint and ecological disturbance and responses, differ by national and regional policy, technology, cultural and social context of resource use, related GHG and risk mitigation strategies, among other biome characteristics. The socio-economic and energy system reliability impacts may be significant, and lead to critical questions in mitigating risk. What type and at what scale do energy generation assets, including distribution grid (e.g. feeder lines), provide increased resilience to both electricity infrastructure while also meeting ecological resilience priorities?

In this chapter we engaged in a discussion of global models and local decision spaces to arrive at a better determination for the opportunity and costs of biomass energy systems, as part of a low carbon, distributed energy system and local decision space. As forest fire regimes are affected by changes in climate, fuel load, and ignition sources, understanding the impact of daily human movements, transport, information flow and daily activities on fuel load and anthropogenic ignitions can help to mitigate the effects of climate variability on occurrence and severity of wildfire (Hawbaker, T. et al. 2013). Policies designed for carbon sequestration and offset activities, must consider the biophysical interactions and co-benefits of these practices and mitigation actions. Hence costs associated with such terrestrial carbon and ecosystem services must be further evaluated. In particular, to manage wildfire risks, this dissertation has investigated to what degree and scale do land management practices (mechanized treatment, prescribed burning and agriculture or agroforestry activities) impact fire risk at a landscape level, mitigate emissions and ecosystem impacts when adjusted for price and payment for services, labor accessibility and population dynamics.

Consideration for this coupled nature-human dynamic system will need to be addressed in the context of local and regional complexity dynamics. As the current status of the world's bioenergy and biomass policies are publicly debated, it is important for the scientific and policy communities to have a more robust analysis of the future economic and biophysical impacts in process based approaches such as the localized SKAILED framework discussed in this chapter.

If supply must equate to demand to develop an equilibrium state, as the way electricity flows, a grouping together of geographically distributed centers into associations or circuits of resource users, managers and consumers that belong to some self-similar process may be the best strategy for allocating labor over land, managing perturbations, both external and internal and adapting a new "Politics of Practice" to a system in flux. The self regulatory model presented in the SKAILED system presented in this chapter provides potential rules for such a politics of practice that can find equilibrium with the frequency of interaction in responding to both local and global stimuli in a more regionally bounded and adaptive decision space with a renewed understanding of the ecological benefits of moving labor over land.

Chapter 3: Internalizing Fire: Learning from a Manzanita Rising

Chapter abstract:

This chapter, Manzanita Rising, engages with the dissertation topic of internalizing fire through discussion of an indicator species as a narrative object in the form of the Manzanita species of plant (Arctostaphylos) and specifically Arctostaphylos Pungens, with common names, Pointleaf Manzanita and Mexican Manzanita. The Mexican Manzanita is a species that ranges across Western North America and has co-adapted with fire cycles that are a major process in the transport and growth of this plant along with mutualisms with human and other living forms. Fire interactions and the chemical interactions with digestion of the seeds, or" internalized fire", in the scarification of the seeds' surface creates a mechanism for the Manzanita's renewal. This chapter begins in a discussion of the historic human uses and indigenous knowledge of this species in both form and function and what this has meant to the current fire ecology of California and North America more broadly. A key question investigated is whether the Manzanita used in traditional ways would augment the habit and structure of Manzanita groves in a more fire resilient structure? To this end, the Chapter includes an economic geographic analysis with open source observational and spatial data and an assessment of the transport and economic operational tradeoffs associated with managing for fire and restoring active management of Manzanita groves and other fire adapted species across the California Landscape. The Manzanita as an indicator species provides a perspective on a living history of fire, lessons across a range of challenges in the paradox of fire regime changes impacting its form and function, and forest health as it resides among a diversity of people, habitats, food and fire cycles. The chapter concludes with a discussion of the costs and scale of Manzanita Mutualisms and opportunities for investing in biodiversity to restore reciprocity across these interconnections.

Table of Contents:

Figure 3.1 Manzanita Mutualisms in three artifacts photographed in California 2023

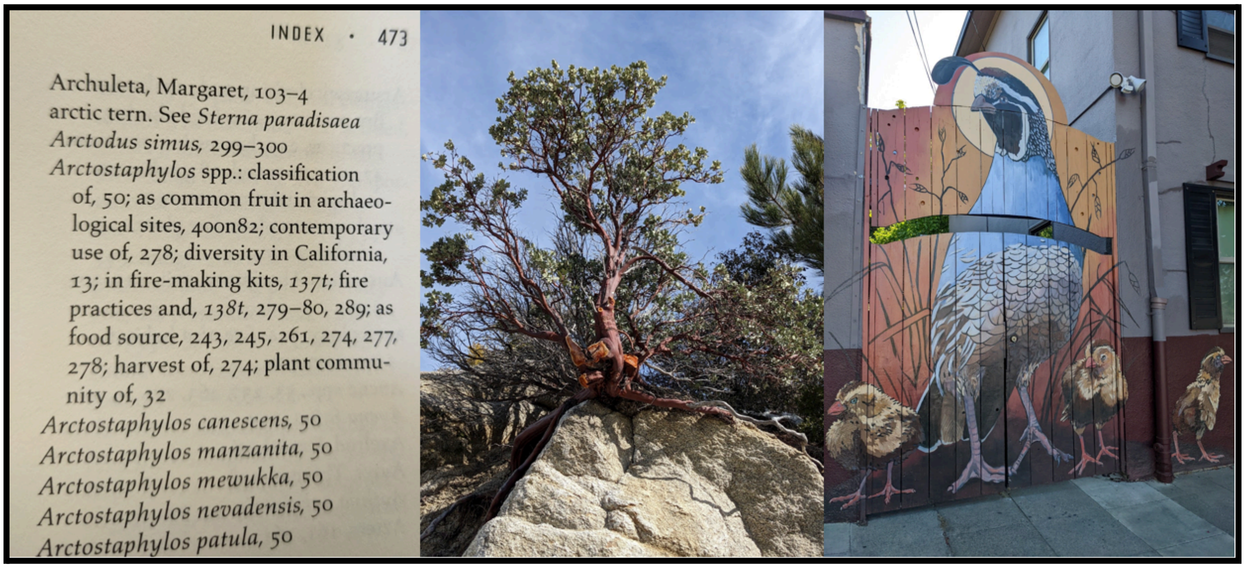


Image: Excerpt from the appendix of Anderson’s Tending the Wild: Native American Knowledge and the Management of California’s Natural Resources; An Image of a Manzanita growing from a rocky outcrop in Central California; A Sonoma County based mural depicting the California Valley Quail, the California State bird that ranges across the Pacific Coast of North America from Canada to Mexico.

3.1 Mexican Manzanita in a living a history of fire: Learning from a Manzanita Rising

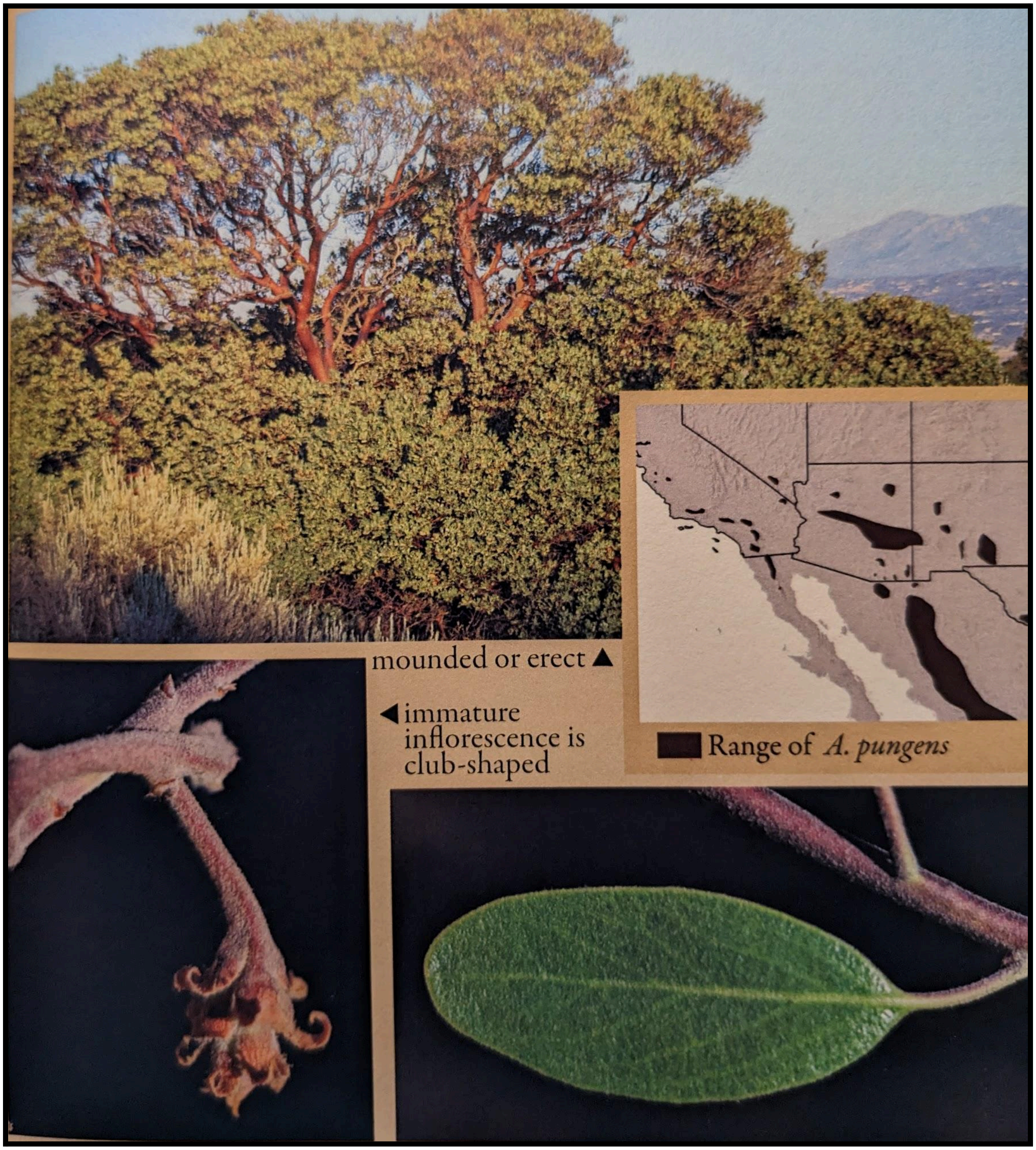
"We have a lot of Manzanita here, they are beautiful, I like to use them for firewood, they burn hot. "

Seiler, landholder born in Los Angeles County, Adjacent to National Forest Land

The Manzanita species includes a large number of varieties across North America. Arctostaphylos Pungens with common names Pointleaf Manzanita or Mexican Manzanita, is widely distributed across the Southwestern United States and northern to Central Mexico and has coadapted with regular fire cycles across its range. It is harvested and made into jam, beverages and other foodstuffs by many people in Mexico and other indigenous communities in North America. The seeds require scarification by wildfire before they can germinate. Importantly, the species forms relationships with mycorrhizae fungi to thrive in gravel and sandy soils and acidic soils (calscape). These and other Manzanita relationships provide examples of interdependence, mutualisms, and histories of fire that are important in the decision to consider restoring traditional structures and habitats of the Manzanita across California.

This chapter, Internalizing Fire: Learning from a Manzanita Rising, begins with a discussion of an indicator species that has co-adapted with human use and fire cycles that are a major process in the transport, growth and renewal of this plant. As Manzanitas are widespread throughout California and adjacent regions, a closer study of the human and ecological interactions of this species in an economic geographic context provides an indication of the impacts and risks of fire that now face the communities of which the Manzanita plant plays an important role in food, fuel, fun and other multiple uses over our landscapes. The chapter concludes with a discussion of the costs and scale of Manzanita Mutualisms and decisions for investing in biodiversity to restore reciprocity across these historic local interconnections.

Figure 3.2. The forms and functions of Manzanita across a range of diversity



Source: Kauffman et al. (2015) Manzanitas a Field Guide, Arctostophylos Pungens or Mexican Manzanita

Learning from an ontological perspective

A study of the Manzanita provides an object for exploration of an ontological perspective on a living history of fire, learning across a range of challenges in the paradox of shifting fire regime changes, dynamically impacting its form and function, as it resides among a diversity of People, Habitats, Food and Fire cycles and practice (Figure 3.1, Figure 3.2).

In Hobbs' ecological treatise on ontology (Hobbs, 1995), an object, such as this indicator species, can appear to take many forms. An example is the determination of a road as a line when we use a map to plan a trip, or the many forms the road may take once the trip commences, as a surface, as a path, a boundary or as an experience as being "On the Road" by Jack Kerouac. Hobbs points to the distinction between an ontological understanding of what something may be characterized or classified as and how it may be used, which can be interpretive based on the creativity or imagination of the individual or human value of the object in relation to other objects. The Manzanita is a species of many forms and functions and defies classification as a tree or a shrub depending on its growth habit in specific locations with differing interacting communities of elemental conditions.

What something "is" in an ontological sense is dependent on culture or distinct methods of sensory observation and social acceptance of such observations, whether this "learning" is scientific or artistic or in between. Hence the narrative object is highly dependent on cultural capacity for characterization, language, experience, and observation or communication and technological media. As humans, we can sense and use tools based on what Pomarlan describes as the object's "disposition," meaning the physical characteristics (Pomarlan, 2022). For instance, does it absorb water, does it burn, can a hand pass through it, can it be held or fashioned into a tool. Over time, the knowledge of the object and its disposition changes and informs the narrative of the object. It is the basis of observation in the scientific method and related process that leads to characterization. Such characterization determines taxonomies and informs our cultural and economic use of such objects.

Individual agents may perceive dispositions differently, yet there may exist general cultural consensus on certain physical forms and hence functions. However, variation across individual agents or "observers" and knowledge of dispositions exists among individuals and across cultural communities. An important aspect of this cultural interpretation or disposition is memory and triggers, that create cognitive linkages across a background and in a dynamic cycle of interactions akin to the discussion of adaptive systems across scales by Ostrom in Chapter two of this dissertation.

Meanwhile, memory and characterization of interacting objects, agents and the background creates another set of complexities beyond the ontological interpretation of the primary object. To bring this back to the Manzanita, we may consider these questions, "Is the mutualistic fungus that helps Manzanitas survive in harsh environments part of the tree? or are they separate? can one exist without the other?", how does the structure and habit of the plant above ground impact the structure and habit of the plant below ground? Can a model or systems approach help examine the interdependence or mutualisms of interactions, events and relations based on an ontological core (Toyoshima et al. 2022). In Pomarlan et al. 2022 their team builds upon Toyoshima to explore learning behaviors in open source and artificial intelligence systems to develop and explore questions at the interface of an agent operating with an object classification and its use to determine the interactions between what Gibson

1979 describes as what the background environment affords to the object and the essence or disposition of the interacting object or agent.

In the context of the Manzanita and its numerous hybridizations across Western North America, it is challenging to consider the Manzanita, without considering the multi-agent interactions over its development and the background environment that has created it as an object in both its classification and its use or value to humans. Perhaps an important process for cognition in this cycle is the process of learning by doing, or "practice" which increases the ontological foundations for an agents interpretation in memory and the potential action in response to a trigger that an event or object may signal in the agent's use or classification of the object and its ecological foundations (Kahneman, 2011, Porzel, 2021, Turvey, 1992). As an ontological lesson, we see the Manzanita interacting with agents, such as humans and other living organisms afforded by the background and cycles of fire that impact the Manzanita directly and the agent directly and indirectly via memory and triggers across scales in an adaptive framework.

Manzanita Rising: Defying simple classification

The common name Manzanita is derived from the Spanish phrase little apples. Estimates of Manzanita Species in California varieties range from forty-three to upwards of one hundred currently identified. Manzanita species are found across dry slopes of Chaparral, oak woodlands and pine forests and coastal range mountains. One of the most common types, the Arctostaphylos pungens occur in the Sierra Madre of Mexico and throughout California and neighboring areas, germinating in the summer in Mexico and the winter in California (Keeley et al. 2012).

As a Mediterranean species, the Manzanita's ability for hybridization and phenotypic plasticity within a fire dependent ecosystem highlights its adaptive response. Hence, the fire regime and the approach to integrating fire on the landscape may prove to have significant impact on the evolutionary cycle and sustainability of specific populations, interdependent species and biomes. The genus Arctostaphylos is remarkably adaptable across elevations and soil types in chaparral and woodland systems with both granitic and sandy soils (Halsey, 2005). Additional localized species of Manzanita exist in "islands" across the range having adapted to other soil types having migrated over numerous climate shifts (Kauffman et al. 2015).

After fire, Pointleaf manzanita regenerates from seed or through layering where intact branches can form roots on contact with soil. As a monoecious plant many pollinators play an active role in the plants reproduction and succession, which is prolific with production of high quantities of fruit and seeds (Lindenmuth and Glendening 1962). Manzanita seeds remain viable in the soil and seedbed for decades while scarification of the seed by fire stimulates germination (Pace and Brown, 1982, Pase and Lindenmuth 1971). Existing in fire-induced climax association, the Pointleaf Manzanita must have fires regularly to thrive across a landscape. Manzanita tends to be a drought tolerant plant that has developed mutualisms with mycorrhizae that provide nitrogen and phosphorous amid shifting fire cycles that affect soil chemistry (Read 1983, Keeley, 1987).

The growth habit of Pointleaf Manzanita can range from a mounding shrub to a tree upwards of 10 feet, depending on the background environment, access to nutrient flows and competition. The Manzanita can flower (white to pink coloration) in many months of the year and are available until late winter benefiting pollinators that may otherwise have scarce resources in that season (Keeley et al. 2012; Fulton et al. 1979). Between fire events Manzanita branches develop layering in contact with the soil at the perimeter of parent plants creating a multigenerational plant community. The Assemblage represents a “fairy ring” pattern with the parent shrub senescing as it ages if fire has not passed through (Caprio, 1994).

Manzanita Rising: a food and fuel tradition across biodiverse species

The Cultural and food ways of the Manzanita are diverse in the context of the habitat they provide for game such as quail, and the cooking fuels that are easily harvested and burn hot and long with dense biomass structures that are easily reachable by both adults and children. The sweet and tart berries have been turned into a pulp, or steeped in hot water and brewed into cider. The berries eaten fresh or produced for ciders, dried berries, jams or aguas frescas provide a nutrient rich food source across many seasons from summer to winter (Bean, Lowell John; Saubel, Katherine Siva. 1972). The berries may still be found dried on the branch into the early winter period. The mosaic structure of the shrub form and small tree form of the Manzanita provides shelter and habitat for small game birds including quail species throughout most of California and the natural range of the plants across the southwest and into central Mexico (Marshall, Joe T., Jr. 1957). The berries also provide food for these and other animals living in mutual adaptation to the fire cycles of the species (Kearney, 1960; Keeley, 1976; Native Plant Information Network, The Jepson Manual, Kauffman et al. 2015).

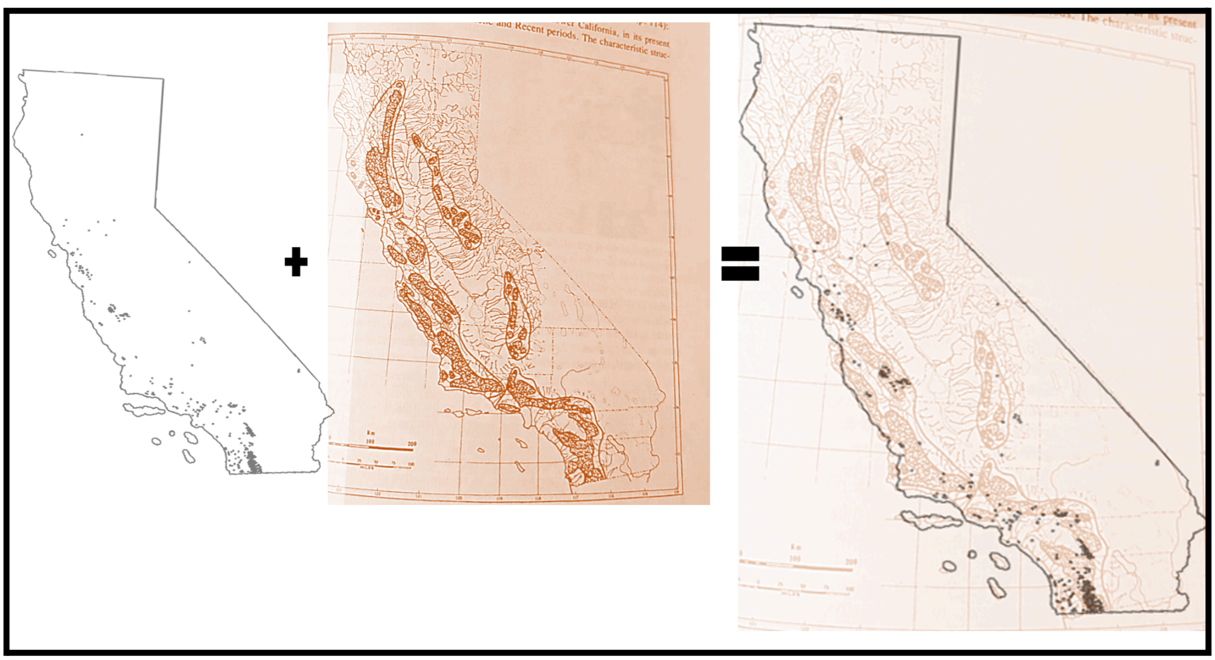
The Pointleaf Manzanita distributed across the woodland and Chapparal biomes of Southern California were used widely by indigenous groups, including the Cahuila people and in Arizona by the Yavapai peoples (Gifford, 1932) who relished them as jellies and used the strong and smooth hard wood in tool making and ornamentation including as smoking pipes, when Manzanita leaves were also smoked in ceremonial process (this ornamentation continues in many artistic expressions today). The leaves were also used in medicine as an antidiarrheal and to aid with relief from rashes caused by Poison Oak (Ron Goode, 2020).

The pointleaf manzanita provides habitat and food for wildlife and livestock. Many wild animals including grouse, quail, turkeys, deer, bears, coyotes, skunks and humans among others eat the berries and leaves along with domestic livestock (Murie, Adolph. 1951; Kearney et al. 1960; Neff, 1974) The production of manzanita for food, firewood and raw materials for construction and tools as well as mixed with tobacco for smoking and other medicinals was common among indigenous tribes of Western North America including in trade in markets in Mexico (Bean and Saubel,1972, Conrad, 1987)

Manzanita Rising in Internalizing Fire: A Case Study in Quail Chaparral Habitat

Chaparral is an important component of Quail habitat in California along the coastal ranges and to some extent in the Sierras and the Mountains of Baja California. Land use, landscape transformation and population pressures of urban extent have had a significant impact on this habitat for quail. Willis Jepson Dean of Botany at UC berkeley in 1930 designated chaparral as a vegetation type. The frequency and historical fire regimes across these landscapes present an area of debate within the fire ecology community and in relation to the application of fire today in chaparral landscapes (Figure 3.3.). Some chaparral shrubs crown sprout after fire while others regenerate by seed, with the Manzanita requiring a chemical process for scarification of its seed in an "internalized fire" metabolic process.

3.3. California Chaparral zones from historical map (middle, Sampson, 1944) across California and Arctostaphylos Pungens observations (iNaturalist, left, 2023).

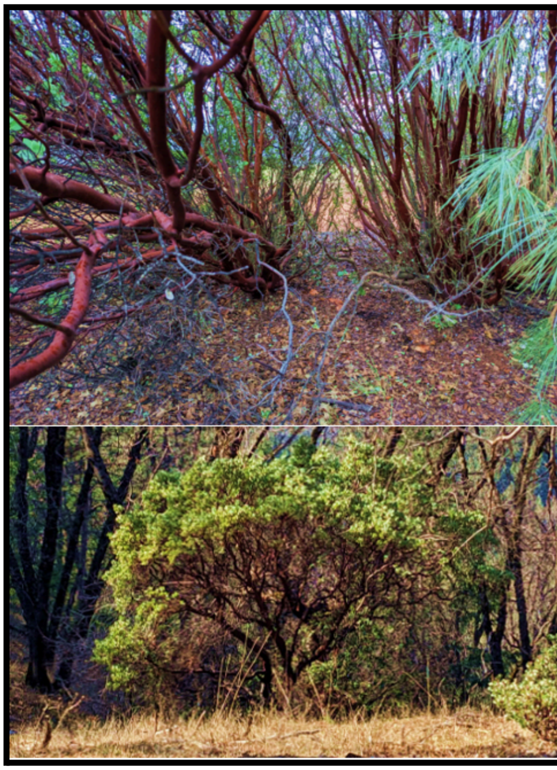


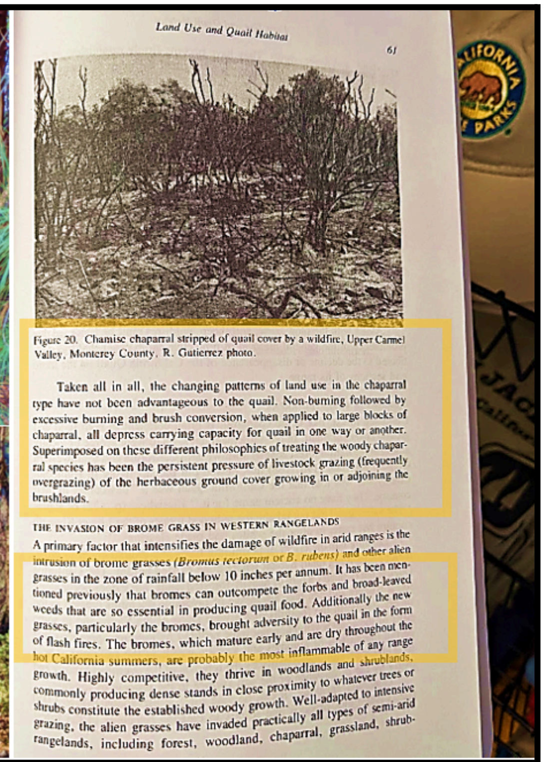
Source: Map of the principal chaparral association areas in the range of the California Quail (Sampson, 1944) overlaid with current inaturalist Pointleaf Manzanita observation data in California (1,398 observations accessed 2024).

Anderson and Ronethal point to the intentional burning of chaparral landscapes to propagate the type and quantity of the flora and fauna used as food and materials in the creation of cultural objects from plant fibers and animal materials. This led to the intensification and extensification of burning as a management and agriculture practice that shortened the fire regimes and led to a diversity and abundant growth of materials across many ethnolinguistic groups that inhabited the Western Sierra Nevada and surrounding areas. There were multiple reasons and objectives in burning based on the intended flora and fauna that would provide useful products through this deliberate and iterative process (Anderson and Rosenthal, 2015).

The image in figure 3.4. depicts potential quail habitat on the left in the undergrowth of Manzanita shrubs and tree forms. The changing patterns of land use and cycles of non-burning and then excessive burning, and over grazing has shifted and depleted the quality of habitat for Quail across California. The image on the right depicts a high severity fire in Monterey County with the destruction of habitat structure and introduced grasses taking over the leafy weeds and bromes that quail use for forage following such events.

3.4 A range of challenges for quail and good burning for good forage





Land Use and Quail Habitat 61

Figure 20. Chamise chaparral stripped of quail cover by a wildfire, Upper Carmel Valley, Monterey County. R. Gutierrez photo.

Taken all in all, the changing patterns of land use in the chaparral type have not been advantageous to the quail. Non-burning followed by excessive burning and brush conversion, when applied to large blocks of chaparral, all depress carrying capacity for quail in one way or another. Superimposed on these different philosophies of treating the woody chaparral species has been the persistent pressure of livestock grazing (frequently overgrazing) of the herbaceous ground cover growing in or adjoining the brushlands.

THE INVASION OF BROME GRASS IN WESTERN RANGELANDS

A primary factor that intensifies the damage of wildfire in arid ranges is the intrusion of brome grasses *(Bromus tectorum or B. rubens)* and other alien grasses in the zone of rainfall below 10 inches per annum. It has been mentioned previously that bromes can outcompete the forbs and broad-leaved weeds that are so essential in producing quail food. Additionally the new grasses, particularly the bromes, brought adversity to the quail in the form of flash fires. The bromes, which mature early and are dry throughout the hot California summers, are probably the most inflammable of any range growth. Highly competitive, they thrive in woodlands and shrublands, commonly producing dense stands in close proximity to whatever trees or shrubs constitute the established woody growth. Well-adapted to intensive grazing, the alien grasses have invaded practically all types of semi-arid rangelands, including forest, woodland, chaparral, grassland, shrub-

If we return to the context of the interplay of the Manzanita as a narrative object in identifying the background cycles of fire and interaction with human agency in burning for the multiple use values associated with the indigenous or co-evolution of this hybridized species, we may conclude that the characterization or classification of the species as a shrub rather than a tree, maybe highly interactive with the cycles of fire and use of wood imagined and permitted. Plant growth that is unmanaged or unregulated for use by agents, whether human or other, may impact the nutrient cycling available to the plant across its range and affect both the structure or form and consequently the observable ecological function that is characterized, measured, monitored and memorized. The Manzanita, thus provides a living history of fire in the form, function and extent that is currently observed, and how it is imagined in our knowledge and learning of its interactions with fire and its many mutualisms such as soil and mycorrhizal associations (Kummerow et. al., 1977; 1986).

3.2 Theory and methods: Paradox of partition and re-sculpting a tree from a shrub

"We use the bark from the Manzanita as a medicinal, to rub on our skin to heal poison oak rash."

Chairman Ron Goode, 2020, UC Berkeley "Fire" Lecture series

"Here daddy, here is some Manzanita bark for your poison oak."

Mia Solene Best, Author's Daughter at 2020 CALTREX Prescribed Fire Training observation

In Anderson and Rosenthal's 2015 Ethnographic and ethnobotany study across nine ethno-linguistic groups in California, they determined that these cultures relied on a replenishing of resources both vegetable, animal and mineral from chaparral communities in the production of useful products. The group documents six ecologically based reasons for burning chaparral ecosystems to achieve known responses for these dense human populations with wide cultural uses of materials. A high frequency of fire, at different stages of ecological succession, was able to augment outcomes across these productive objectives in the production of diverse plant materials to support food, medicine, technologies and cultural traditions. High fire intervals were able to increase economic productivity for these communities over long periods that resulted in fire adapted ecosystems. The paradox of partition that has led to manzanita's void of management has now contributed to manzanita as a fuel for catastrophic fire, instead of food for fueling daily life.

Given the common occurrence of Mexican Manzanita across California, it is likely that the wide use of these products and the interacting ecological functions over time led to the wide distribution, including hybridized forms across its current range in California. Today, Pointleaf Manzanita is found in the understory of oak woodlands, a common food source for indigenous populations, in the Coastal ranges and Sierra Nevada and across the State of California and into the Sierra San Pedro Martir in Baja California. Several oak species across these areas and the adjacent savannah and grasslands provide a mosaic for Manzanita to find a natural place contributing to the food sources available to indigenous communities. The aforementioned theory was developed in the course of review of literature, ethnographic and participatory research work learning in the field through observation of individual species and landscapes while practicing survey work, field preparation and engagement with prescribed fire associations. These methods were further complimented by the use of open source data and tools to develop simple geographic information analysis to estimate theoretical transport and temporal costs of Manzanita grove management in California under different transport options.

Participatory and ethnographic approaches

Practices today to reintroduce prescribed fire in ecological and food production environments have included active engagement with indigenous communities and other inhabitants of California's ecosystems to learn and reintegrate a variety of burning and ecological management practices. Personal participatory experience in the Nature

Conservancy's California Fire Exchange Programs (CALTREX) held in 2020 included burning under these oakwoodland and savannah areas that were populated by large Manzanita trees and shrubs as depicted in Figure 3.5. The Manzanita on the left stands upwards of four meters in a rocky terrain that limits the amount of direct fire flames that the Manzanita can be exposed to. The rocky outcropping with a Manzanita growing at the beginning of this chapter in Figure 3.1, also depicts an evolutionary advantage to the Manzanita's ability to survive in granite and rocky soils across its range to isolate it from high intensity fire.

Figure 3.5. Fire in the field, storytelling and learning by doing

Images: Author's daughter, Mia Best, age seven, climbing a Manzanita tree, during the author's participation in the CALTREX Prescribed Fire training in Sonoma County at the Audubon Canyon Ranch Preserve, Fall 2020.

The prescribed fire training and experimental process in the Bouverie Ecological Preserve, of Audobon Canyon Ranch, is nestled in the historic Sonoma Valley that has experienced catastrophic fire events in recent years. Representatives from the Coast Miwok community, including the Nelson family, ignited the fire following a historic narrative of the indigenous communities' use of plant materials and traditional fire stewardship practices in these areas. This narrative of both use and classification of important indigenous plant types included a story of family histories and lineages, stories of migration and displacement.

At these Caltrex events, volunteers and local fire district staff participated in several burns during this experience to both enhance ecological and operational learning across this community of stewards. Participation in these events requires significant preliminary training and certifications, time allocation and manual labor associated with the existing and evolving requirements for managing prescribed fire in California. Observers also participated from the local community to build awareness of both process and ecological effects, that included neighbors and children actively encouraged to watch and learn the objectives and processes related to reinstating prescribed fire as a landscape management strategy.

Each landscape to be burned has a unique indigenous legacy and story of migration and displacement. Similar to the variation in fire regimes across geographic regions that reflect both cultural and ecological backgrounds, the story of each plant species may be layered with the histories of plant introduction and management, as the story of seed transport by living carriers intervenes.

In the case of areas in the Madrean pine-oak woodlands of the La Michilia Biosphere Reserve in Durango, Mexico, prior to 1930, the fire return interval ranged from 3 to 37 years. Short fire intervals are often characteristic of smaller or patchier fires in lower altitudes, while longer fire intervals are typically linked to larger fires at higher altitudes (Fried et al. 2004). According to Pace et al 1982, Chaparral across Arizona, New Mexico and borderlands burned at intervals of 50 to 100 years at high severity, while Payson et al and others suggest a fire return interval under 20 years with small fires in Southern California and Baja California. Caprio points to older Manzanitas above 30 years of age that can grow to 6 m in diameter. Across this range of conditions and historical fire intervals there exists a question of human agency in the habit and structure of manzanitas. If the agent prefers vertical to horizontal growth of Manzanita species, “What labor and approach may be taken to augment the growth habit of a Manzanita grove?” To what end and what use? Who may be available to help? Do we have any volunteers, or “unaccustomed labor” willing to assist in pruning and tending operations? To restore an entangled source for food, forage, fire, fungus and fun (Figure 3.6). The density and high heat attained in manzanita wood firing may assist in specialty production for instance contemporary use in hearths, ovens, and wood fired pottery kilns (Oesteritter, 2020).

Figure 3.6. Entangled Sources of Food, Forage, Fire, Fungus and Fun

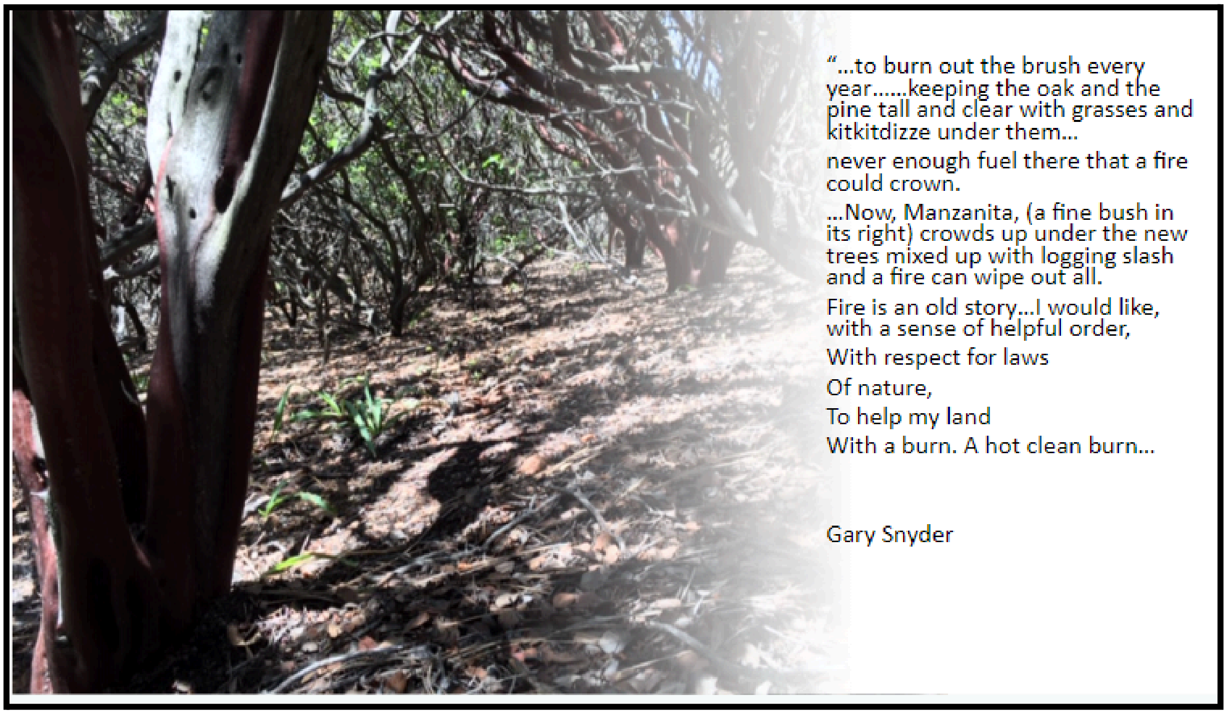
Source: Ethnographic and fire ecology fieldwork in Annadel-Trione State Park and Sonoma Valley.

The image on the right shows an interface of chaparral and pine forest that were impacted by high severity fire, causing mortality across large Manzanita plants visible in the foreground with new chaparral growth in this photo taken in 2022, during ethnographic and field survey work. There is an active California State research program to examine the use of prescribed fire and other fuel treatment types across several sites within the State Park to examine ecological effects to oak mortality and other vegetation types. Additional research to examine the impact of manzanita mortality and habits of growth may expand the understanding of the types of long term mutualisms and vegetation effects, including wildlife habitat, that may benefit from an active treatment program expanded to focus on Manzanita tall (tree) growth regeneration, in the context of prescribed fire, fuel reduction and recreational activities within the State Parks and surrounding areas.

While prescribed fire and related ecological research has been around for decades, an expanded approach is needed along with operational capacity to mobilize the active engagement of volunteers, citizen scientists (i.e. iNaturalaist observers), the academic community and State Parks among other human and institutional resources to support a focus on adaptive measures to minimize the risks posed by unmanaged manzanita leading to high severity fire across the State and adjacent areas. The active engagement in filling management gaps and resources to support these activities across public and private lands is an area that requires additional research, applied theory, and policy to initiate long term stewardship programs and expand inclusion and participation of related human and funding resources.

As discussed in the regional scene setting in Chapter one, this is an old story with much complexity in movement of people and plants. A Poem written by Gary Snyder in his poetry book entitled, Manzanita, calls to action the restoration of a sense of helpful order to the natural landscapes "with a hot clean burn," in the way indigenous communities would "burn out the brush every year" (Figure 3.7).

Figure 3.7. A hot clean burn clearing the way for respect for laws and poetry



Residents of California and its flora and fauna are facing the necessity of finding ways to enhance the integrity and livability of their ecosystems (Barbour et al. 1993; Jensen et al. 1993). The diverse ecological relationships understood by California's indigenous communities and our integrated knowledge of global change affords a moment in time to re-evaluate and internalize neglected values to address global, regional and local problems simultaneously. The practice of enhancing cultural and biological diversity is a foundational step there in (Manley et al. 1995).

3.3. Slow Fire: An approach to revitalizing mutualisms, managing Riesgo in fire over land

Contrary to current sociological discourse on climate and the environment, the risk of increasing fire from climate change is not an emergency, it is the result of long term processes out of ecological balance that require alternative, and at times paradoxical, long term processes in order to rebalance. Yet there is urgency in decisions to enhance mutualism and change our behaviors in the short term as plants and ecosystems face extinction. The actions adopted need to be long term and widespread, the way that indigenous communities managed their resources to produce ecological and evolutionary consequences in the biota (Blackburn and Anderson, 1993). The idea of preserving and protecting “self-maintained” island communities in a “wilderness” state at the exclusion of diverse peoples and cultures is a fallacy. The time to act may be now, however, what is needed is not an emergency response, but rather a long-term management of migratory movements that will occur and cause small-order repercussions with aggregate major effect, en economic geographic framing of regions and setting the scene as stated at the end of Chapter one. In the face of uncertainty, a “climate emergency” conjures a fight and flight response. The urgency to act in the face of uncertainty, may be taking long term steps to integrate slow fire, taking time and attention to observe, learn and safely transport fire by hand over the landscape (as shown in figure 3.8). Then repeat.

3.8. Slow Fire: Transporting a burn through douglas fir, pine and Manzanita

Image: Left. Manzanita amid a mixed conifer and broadleaf forest managed for carbon, timber and climate values. Right. A prescribed burn association conducted with slow transport of fire with hand tools to reduce flame length and encourage the slow movement of fire on the landscape to preserve carbon stock.

Slow fire offers an opportunity to experiment, observe, calibrate, collaborate and scientifically test assumptions and record results at a micro scale, to cause and effect small-order changes. In an approach to adaptive management in the face of catastrophic fire , there is a resurgence of varied techniques and local perspectives that are engaging with this problem space. In a people’s science of fire (figure 3.9) local fire districts, prescribed burn associations, non-government organizations, academia, volunteers and other institutional actors are exploring and adopting new processes to recalibrate our response to fire on the landscape. Whether we characterize fire as “good” or “bad,” “new” or an “old story,” what is required, in Gary Snyder’s words, “is a sense of helpful order, with respect for laws…Of nature.”

Figure 3.9. A People's Science of Fire: Experimentation across hoods and woods

Without fire, very old stands of Manzanitas are susceptible to encroachment by conifers. Pointleaf Manzanitas at higher elevations are faced with mesic pine forests that if not burned over in a regular interval will favor these conifers over the oak woodlands and chaparral where larger pointleaf find their place . Successional replacement of pointleaf Manzanita is the result of fire exclusion that enables other conifers and other plant forms that thrive in a fire-excluded environment (Reference prescribed fire study). Figure 3.10. demonstrates the range of pointleaf manzanita across North America based on 6,191 recorded observations of the plant using the open source aggregated observations of the iNaturalist online community. The data shows high density of observations across Central Mexico, The Sierra Madre, Northern Baja California, Southern, central and northern Arizona and Utah and across the coastal ranges of California and surrounding areas of the Central Valley. For California, this recent data of (1,398) observations reflects the historic range of chaparral zones in 1944 shown in 3.3.

Figure 3.10. Observations of Arctostaphylos Pungens (6,191) Across North America based on inaturalist data; Across California (1,398)

Data Source: Inaturalist Arctostaphylos Pungens Observations

The degree to which manzanita can thrive in a fire-introduced environment depends heavily on the degree of fire severity across the landscape. While fires can regenerate manzanita seed and reduce competition from other plant seedlings such as conifers, low severity and high severity fires may have different results. Fule et al.'s 2000 study demonstrates the effect of fire on Pointleaf manzanita stem densities across burned and unburned plots. Their team identified 491 stems per hectare on unburned plots compared to 4625 stems per hectare on adjacent burned plots 11 months after burning (Fule et al. 2000.)

Based on the focus of grazing across California and much of the Southwest in the mid 20th century and conservation measures seeking to preserve wildlife habitat, fire suppression policies led to the stand conversion of pointleaf manzanita and other chaparral species to grasslands (Lathrop and Martin, 1982, Martin 1982). Lathrop and Martin study also found that prescribed fire in winter months conducted on Jeffrey pine and Black Oak woodlands killed pointleaf manzanita plants, however did not result in enough fire to germinate belowground seeds. They found pointleaf densities two years after the fire were much smaller at a 93% reduction than adjacent unburned plots.

While fire is essential for the propagation of pointleaf manzanita, a high frequency may eliminate manzanita based on mid 20th century research on reducing stands of pointleaf conducted by Biswell and Schultz. They found that a prescribed burn resulted in 100% mortality of all new growth, three years after an initial fire. The manzanita that had not yet matured to produce seed and subsequently no new seeds sprouted (Biswell, 1958). Alternatively, if fire is not integrated into the landscape based on historical regime, chaparral may encroach into grassland or oak woodlands, raising fuel loads and risks to oaks and other species (Pase, 1971). Figure 3.11 shows varied structures and manzanita cover in a fire-excluded environment with fuels build up and dense manzanita vegetation cover leading to increased density of fuel loads and potential risk of high severity fire.

3.11. Variation in fuel structures in Manzanita groves and landscaped ecosystems with fire exclusion.

While fire frequency and fire severity may lead to mixed impacts to manzanita, prescribed fire may result in reduction of manzanita cover, germination of manzanita seed, increased forage for wildlife browsing, and minimal erosion in watersheds and other ecosystem benefits or encroachment by new vegetation types as shown in figure 3.12.

Figure 3.12. Manzanitas and a Range of Risks in Balancing Form and Function

Images: Manzanitas in Sonoma County under !Precaution Zona de Alto Riesgo!

3.4 Manzanita Rising at what Cost and Scale? Applying a Labor Over Land (LOL) Model

The Manzanita, the Arctostaphylos, as an object, beyond food and fuel, is a source for poetry and artistic expression. The name in Latin is derived from the meaning a "grouping of bear grapes." Like the adaptable bear, it is a survivor. As a species that hybridizes and survives across a range of environments augmenting its habit amid its mutualisms. Its survival in rocky outcrops (Figure 3.1) across a range of climate variables (Figure 3.10) in sandy soils and extreme conditions, its nature appears almost human, requiring community, attention and care. Managed manzanitas can be seen across neighborhoods and campuses due to their aesthetic beauty and representation of California's ecosystems. Figure 3.13. on the left, shows one image of the many pruned Manzanitas rising on the University of California, Berkeley campus. These Manzanitas have been manicured and cultivated routinely to "branch up" and demonstrate a "pristine" environment and natural beauty, which includes regular pruning and litter removal, among other landscaping provided by the University of California facilities staff and other caretakers.

Figure 3.13. Manzanita as a source of art, inspiration and creativity in labor and transport

Source: for Gary Snyder (1972) Manzanita cover image available at Bancroft Library.

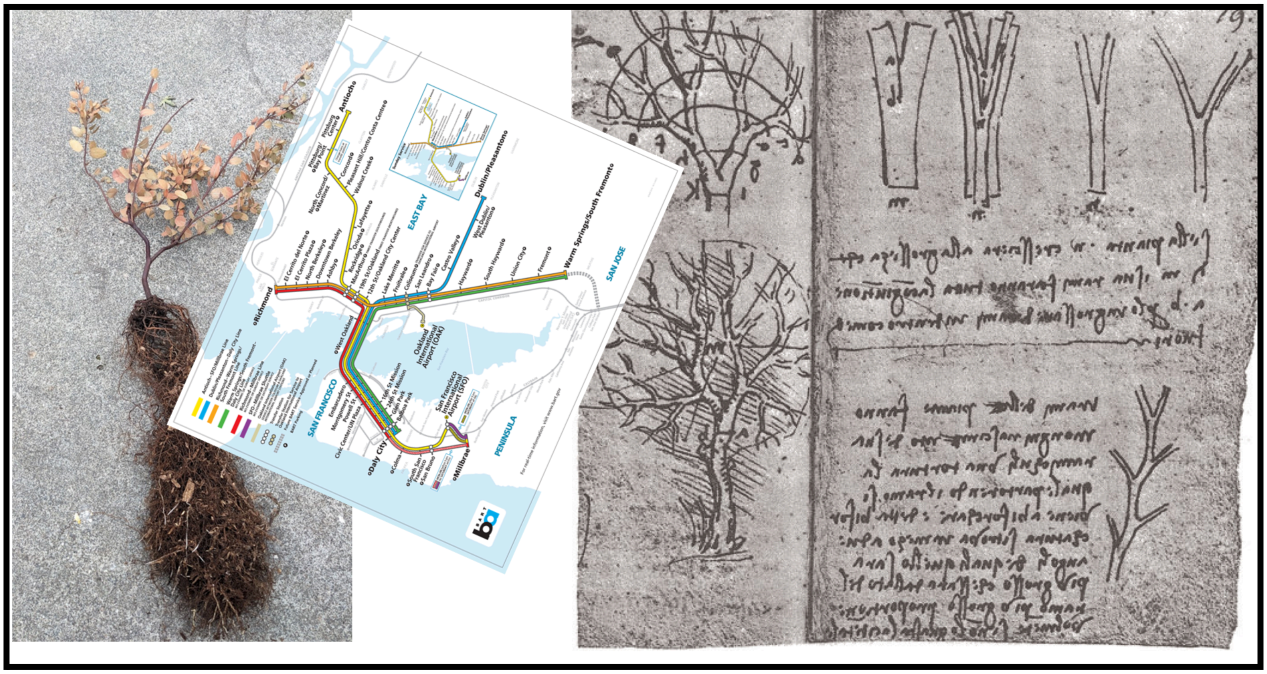
Images: From left; Sculpted Manzanita on UC Berkeley campus reaching 2 meters high. Cover shot of Gary Snyder's poetry book Manzanita (1978) available at the UC Berkeley Bancroft Special Collection. Images of Manzanita's entangled and elegant growing habits taken at two separate California State Parks locations.

Care for our landscape and natural systems in the biota is part of our human legacy of mutualism, it operates to integrate “a helpful sense of order” and is part of “respect for laws…Of nature.” As agents interacting with objects, we learn and are afforded values through this mutualism, this regenerative understanding in the impulses that trigger our memory and inspire our imagination, creativity and economy.

In an ontological sense, such impulses rely on our background knowledge and experience and the transmission of that knowledge through experiential learning, in learning by doing, and through narratives and storytelling. For instance, what we identify as a “fine shrub in its own right” to quote the poet Gary Snyder, brings us back to the earlier ontological questions posed in section one of Manzanita Rising. “What is a tree?” or perhaps “What is the distinction between a tree and a shrub?” When I posed this question to Tom Parker, a botanist and ecologist in California who co-authored the field guide to Manzanita’s, he commented something to the effect of, “well it's not very clear, you have really hit on something.” For instance questions that arise from McMahon’s early work on the “Size and Shape in Biology” and tree structures based on mechanical design and architecture in growth habits in Seidel's work further frame these questions (Mcmahon, 1973, 1976; Seidel et al, 2019). West and Brown further discuss other unifying theories in scaling laws in the biological structure and organization (West and Brown, 2005)

The distinction or classification and characterization of a tree as an object, may be similar to that of the road as a line, as discussed earlier in Manzanita Rising as an Object Lesson. The branching of a tree, and the branching of a road or transport network, may appear to have uncanny similarities, but in fact it is not that unfamiliar for botanists, biologists and ecologists to consider the vascular systems of plants as communication, transportation and distribution networks (Sone et al. 2009). Perhaps, in a similar way that road networks and “right of ways” play similar roles in a benefit to cost ration in human societies transmitting nutrients, raw materials and impulses across the network (Figure 3.14).

Figure 3.14. Branching across networks: Regulating flows in biological forms



Images: (Left) Authors failed attempt of creating a Bonsai from Arctostaphylos confertiflora is a rare species of manzanita known by the common name Santa Rosa Island manzanita, listed as an endangered species; (Middle) Bay Area Rapid Transit Map; (Right) Da Vinci's treatise on the Tree Rule. Eloy, Christophe. "Leonardo's Rule, Self-Similarity, and Wind-Induced Stresses in Trees." Physical Review Letters, vol. 107, no. 25, Dec. 2011,

As we have demonstrated in this chapter, the management of landscapes takes time, it takes care and it takes active knowledge, memory and the awareness of stimulus that trigger an agent's response and effect on the objects that surround and interact with us across our landscapes and over space and time. The structure of objects or fuels, their composition and the aggregate small-scale repercussions of individual "births" and migrations create the affordances of our natural environment where agents interact. In Manzanita Rising we observe the iterative decisions of humans and other mutualistic agents living in proximity and connection with structures as they develop and evolve through transport, and agent actions, or labor, over land.

An example in the below figure 3.15. from both an actively managed urban landscape system with a Manzanita cultivated for its use value as aesthetic landscaping on the University of California campus. The object is cared for with regular pruning, litter removal and consideration for fire hazards in and around a built environment. The red circles in the image demonstrate the branches that have been pruned over the lifetime of the plant, which has been sculpted into a tree-like form. On the right we observe a manzanita with dead and dried branches creating fuel continuity from the ground up to the tree canopy. This Manzanita that resides in the Annadel-Trione State park has a similar structure to the Manzanitas in and around the oak woodland that experienced high mortality during the recent 2017 Tubbs and other fires that impacted the State Parks.

Figure 3.15. Pruning to foster vertical growth, aesthetic value and fuel reduction

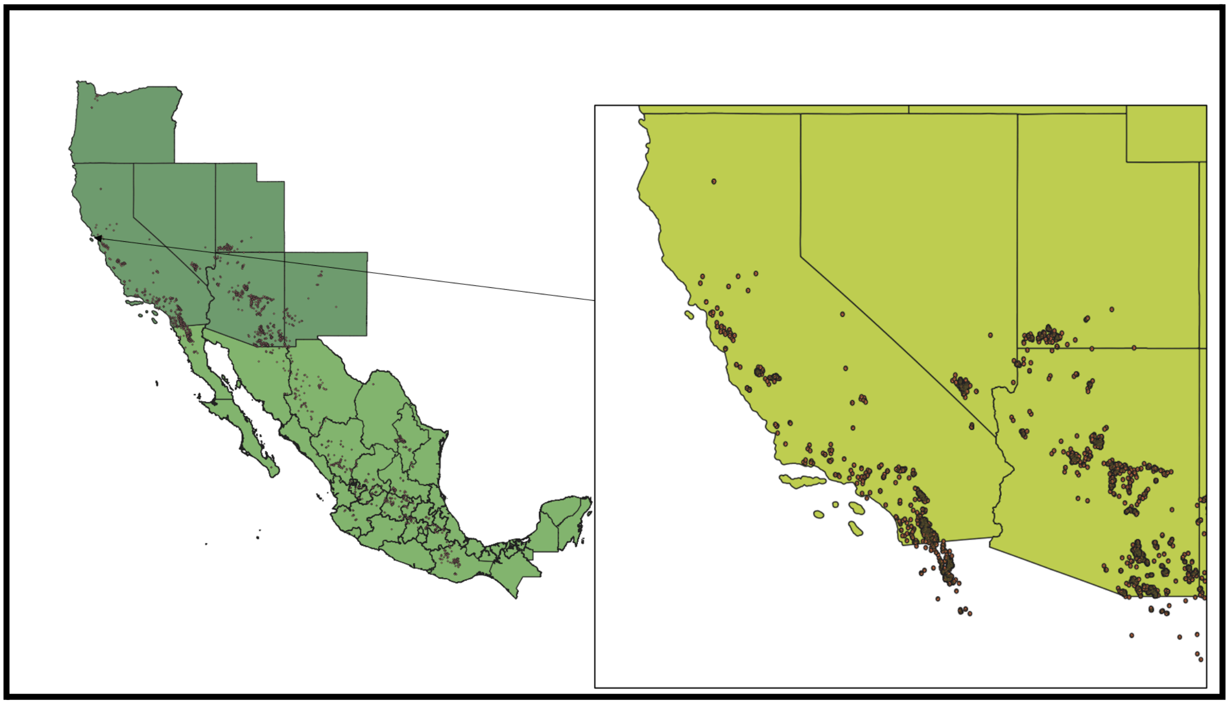
Note: circles on left depict the point of landscape pruning. Circles on right depict opportunities to prune for reduced fuels and vertical tree growth.

In the image, red circles represent the potential for pruning branches to foster a vertical habit and clear low hanging branches and dead fuels that pose a fire hazard and threaten the trees survival as a grass fire may transport fire up into the tree canopy. In the absence of lightning fire to alter this fuel build up, human labor would be required to manually offer treatment by thinning, removal, pile burning or possibly prescribed fire. Active research on fire effects in this and other State Parks is ongoing, and more could be done with enhanced resources. Expanding attention to the survey and composition of data, and treatment effects in the context of Manzanita and their present ecological condition and fuel effects across such landscapes requires more attention. Field notes and indications from existing research in the field offer potential for expanding inventory protocols and procedures to consider fuel structures and type in novel ways, based on observations during the 2022 Summer Field work as highlighted in Figure 3.16. A broader inventory, classification and assessment of large Manzanita's in the park may be an initial research focus in this area.

Figure 3.16. Fieldwork in Northern California amid Manzanita groves

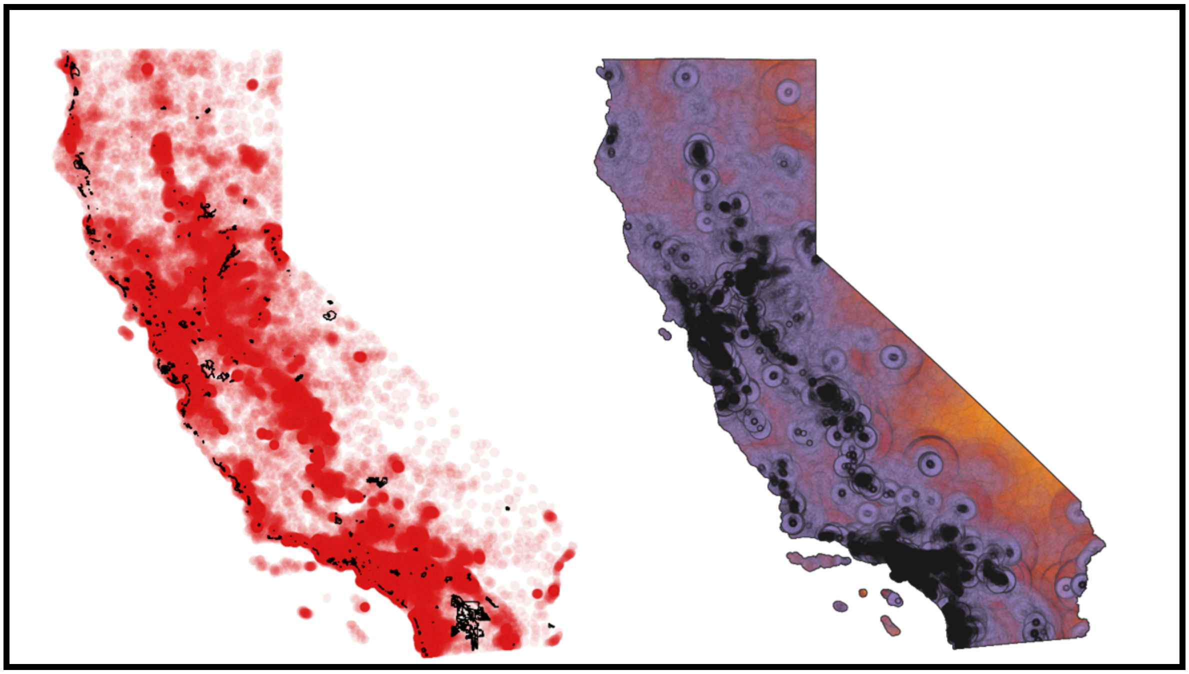
As indicated based on the below iNaturalist data, the distribution of Pointleaf Manzanita is broad across the region from Southern Mexico following up the Coastal Mountain ranges towards Oregon. The data include sporadic observations in Northern California, with the most Northern cluster of observations around Sonoma and adjacent counties, where the Annadel-Trione State Park is located. This crowdsourced data in figure 3.17. provides an indication of the current range of this manzanita and considerations for the evolution of this species in California's management of fire, forest, landscape and climate policies.

Figure 3.17. Recent iNaturalist observations of Mexican Manzanita



In Chapter 2, of this dissertation a model for assessing availability of localized labor, labor time and transport options based on a normative comparative cost analysis across transport options. This model based on a random distribution of points for each census tract approximates a small percentage of the population that may be available for field work across California. This distribution is highlighted in figure 3.18 maximum transport distances of 20km provides zones highlighted in red circles, which indicate operational areas from points at a least cost distance traveled.

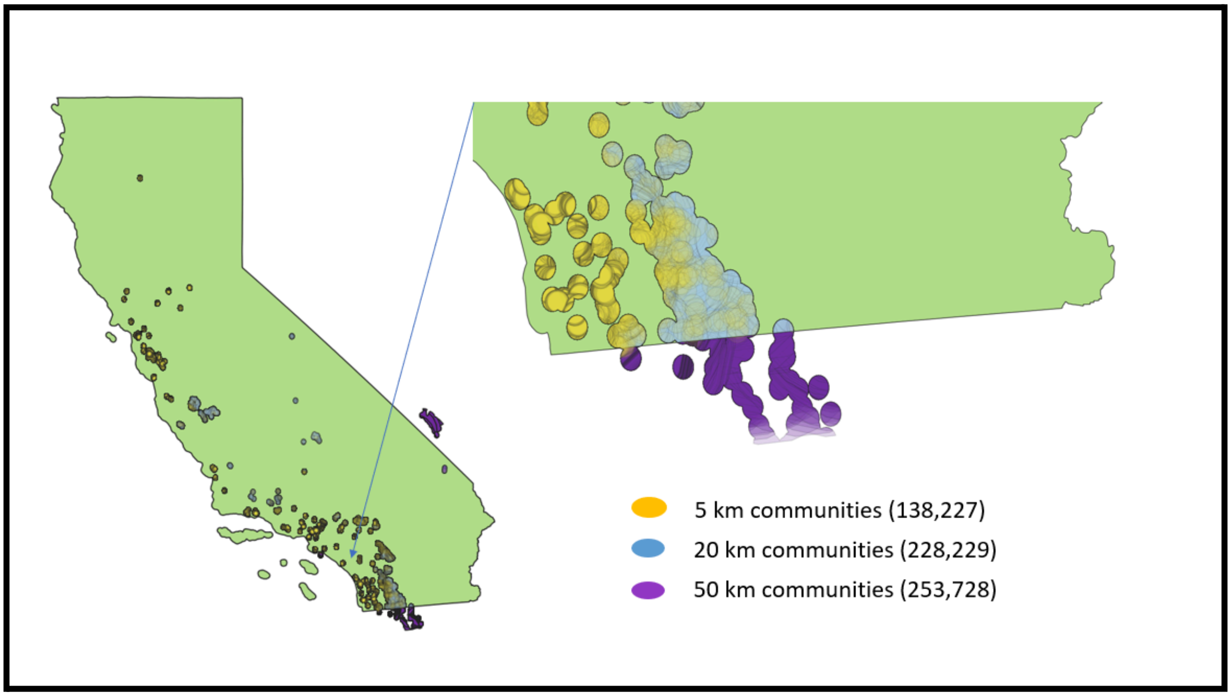
Figure 3.18. Internalizing Fire from Chapter 2 with a Labor over Land Approach



The figure on the left includes an overlay of a Geographic information system (GIS) Shapefile layer of boundaries of existing California State Park areas. Many current State Parks exist in areas overlapping with operational capacity in the red regions. This suggests an available workforce at least travel cost to most park areas. Conversely, There are many red areas with available labor, but no existing State park in vicinity to benefit from the workforce.

If that available workforce were able to be mobilized in proximity to existing Manzanita groves the associated costs of transporting populations by various means are estimated based on the model described in chapter two and run with the individual counts of iNaturalist Manzanita observations. Results from this analysis demonstrate a theoretical potential of human capacity within varying proximity that may be compensated for their labor and transport costs to tend these Manzanitas over time. Figure 3.19. identifies three ranges that people may travel with varying transport options and estimates the varying potential of workforce that may be mobilized in each transport scenario including walking (138,227 participants), bicycling (228,229 participants), and internal combustion engine or electric vehicle transport range (253,728 participants).

Figure 3.19. Internalizing Fire from Chapter 2 with a Labor over Land Approach



These figures provide a theoretical potential based on where people are approximately available today to labor on the land in proximity to recorded observations of Pointleaf Manzanita. As discussed in chapter two a more future oriented distributed population scenario may look different in the context of providing more randomly placed housing across landscapes that may be more coincident with existing or future observations of Pointleaf manzanita. Such a distributed or repopulation scenario could provide transport and labor time cost saving in the this type restoration and ecological management option providing more energy efficient and economic cost reductions for “tending the wild.” Presumably, such a random population scenario assumption would provide more walkable and bikeable options to engage in ecological management at a lower environmental and economic cost. Figure 3.20. provides an indication of the results for this analysis in a business as usual scenario where participants from the general population are not randomly placed across the landscape, but are rather randomly distributed within existing census tracts based on proportional representation of existing population in those areas today.

Figure 3.20.. Approximating Manzanita Treatment Utility with Labor over Land

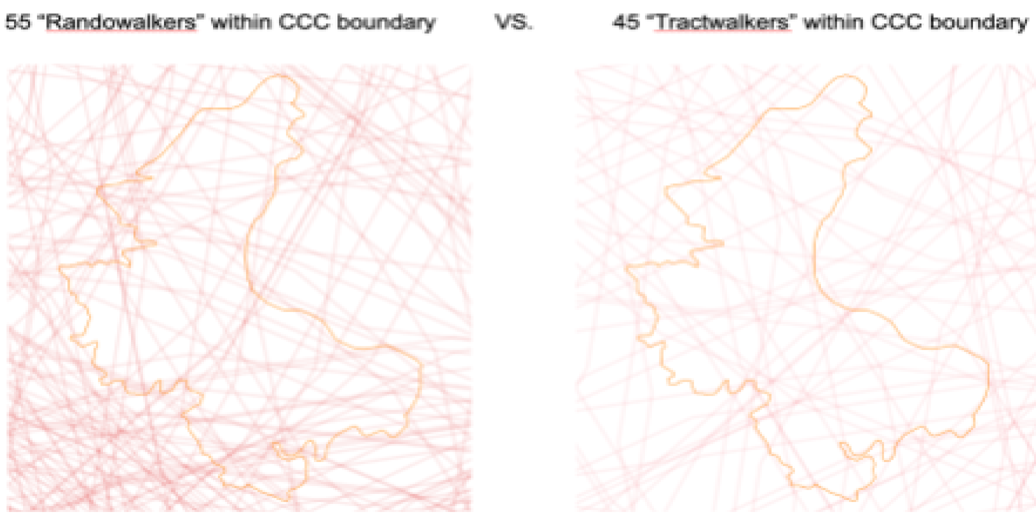
VMT Type	Transport	Relative trip cost	Time Cost	Relative Wellness Utility at Locality	Potential Energy Extraction Value (flow>20km)	Total PAX	Normative Value at Locality of Individual Trip	Normative Max Value of Treatment Utility at Locality
5 km communities	Walk	-1	60 min	5	-1	138,227	5	691,135
20 km communities	Bike/shuttle	-2	60 min	4	-1	228,229	2	456,458
20 km communities	Motorized Bike	-3	60 min	3	-1	228,229	1	228,229
50 km communities	Combustion Vehicle	-4	60 min	1	1	253,728	-0.25	-63,432
50 km communities	Electric Vehicle	-5	60 min	2	1	253,728	-0.4	-101,491

Normative Max Value of Treatment Utility at Locality = (Relative Wellness Utility at Locality)/(Relative trip cost)((Potential Energy Extraction Value)(Total Participants)

Based on these results for potentially geographically available participants and relative normative weighting assigned by indicators of wellness, transport option costs, potential energy or product extraction value (for instance food or fuel, fiber benefit) for each currently available transport option a normative Maximum treatment utility is estimated at the locality of all Manzanita locations based on Inaturalist data to provide the ranked values shown in the above figure when multiplied by potential participants in proximity to the maximum range of the transport option.

Based on these results the normative weighting demonstrates a high value for a community in walking proximity to these manzanita locations, followed by biking or shuttle access, motorized bike with internal combustion vehicles and electric vehicles having an extractive or greater externalized cost given the higher embedded and capita cost and fuel and infrastructure required for these transport options. This scenario aso weights an extractive value of potential products exiting the local system as a potential energy extractive value or outflow from the locality. A more detailed weighting may be done based on local and community decision on objectives in common resource management based on the discussion in Chapter two of the “SKAILED” criteria. This weighting provides a -1 extractive value and a positive extractive value for resource flows out of the units.

Figure 3.21. Example of reachability with least cost option with distributed population



Note: Civilian Conservation Corps State Park Boundary with overlapping radius from population points.

The above figure 3.21 shows the potential for more accessibility to reach field site projects within State Parks boundaries using one location of the Civilian Conservation Corps site in Central California as it would be accessible by people walking to a project site in the scenario on left depicted with a random distribution of participants throughout the State and on the right the number that can be reached from existing participants randomly distributed in existing census tracts. In a random repopulation and distribution scenario 55 participants would be in proximity to access these sites by walking while in the other scenario of existing population density 45 participants would be able to reach the site in a least transport cost option.

For the State and in the existing population scenario as shown in figure 3.20 total participation with vehicle transport is increased from 138,227 for walking modes of transport to a field site to 253,728 participants with individual vehicle transport, the more energy intense vehicle transport coupled with a positive extraction value for energy transferred out of the system increases the overall cost of these forms of transport given the normative weighting and wellness criteria included in this analysis. These values may be adapted to local prioritization and circumstances to develop an optimal mix of participation and transport modes based on localized project objectives and treatment considerations, such as the need for fuels removal, heavy equipment or more labor availability and seasonal variation in a given project or location in an adaptive stewardship model.

These results provide a preliminary model to assess operational costs of future volunteer, staff housing or other paid labor across a range of time and transport cost variables useful for operational and environmental estimates of future project costs.

3.6 Manzanita Mutualisms: Investigating and investing in California mutual communities

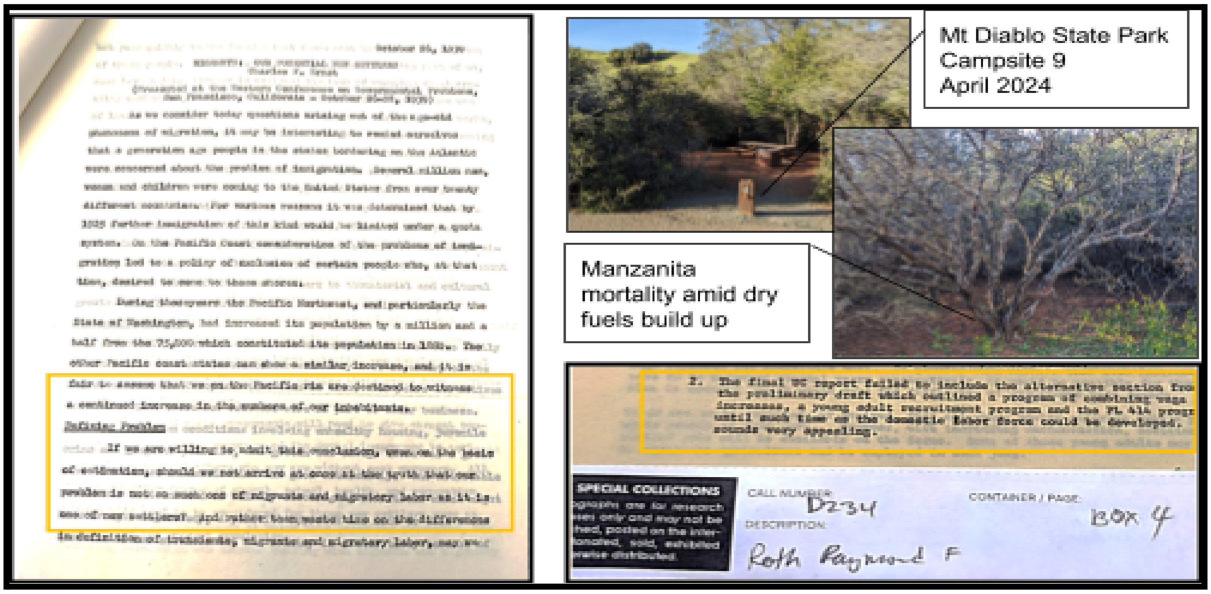
In this chapter the discussion of the Manzanita as a cultural object interacting with diverse and distributed human populations, migrations and the multiple uses of the species and interconnections with human and environmental factors has brought us into a relationship of learning from the past and imagining future stewardship scenarios that may be able available to respond to the shared challenges experienced with the rise of catastrophic fire. The reflection on the manzanita as it is rising, provides perspectives on the mutualistic benefits that may come from restoring the spaces and places the manzanita and people inhabit together.

Perhaps we can once again learn from biological processes in considering the workers that may be available in the restoration of our landscapes. As mutualisms involve exchange of nutrients, services or commodities that are beneficial across species, in the case of Arctostaphylos pungens in which flowering occurs from Jan-Apr at most sites, sporadic flowering can take place at almost any time of year. Common floral visitors include thrips, Anna’s hummingbirds (Calypte anna) removing nectar and feeding on thrips, a food source reported for other hummingbird species as well (Bené, 1945). Honey bees have repeatedly been noted to function simultaneously as legitimate pollen-collectors, legitimate nectar-collectors and secondary nectar-robbers on a single plant species. Taking these examples of multiple types of services with diverse benefits, the labor over land model may be applied to location specific treatments with this indicator species in mind, to provide diverse ecosystem benefits in the restoration of tall Manzanitas for local food supply benefits, which include habitat for diverse pollinators, the State bird and more.

Lessons from the past may advise on the placement and a settlement of a workforce in the future to manage these landscapes whether by visitors, volunteers, parks staff or a locally mobilized workforce. A visit to Mt. Diablo State Park in April, 2024 perhaps lends a lesson, passing through the campsite, a team of young conservation corps trainees were camped out in the group camp site. Passing them by campsite nine, among others, stood out as an overgrown example of an underfunded vegetation and fire risk management program, the site which was mixed oak woodland and chaparral had signs to prohibit the collecting of fuel wood, yet the campsite was severely overgrown with dry, dead wood and leaf litter. Site 9 also was formerly a home to this dead manzanita, in its dry form adding to the potential fire risk figure 3.22. It was a reminder that lack of Manzanita care has a recreational impact in the contradiction between conservation, recreation and fire ecology. On the other hand, the mobilization of this young corps of future stewards offers promise for biodiversity. This is dependent on learning lessons from the past in the sustainable allocation of labor over land in future stewardship models.

The last figures in this chapter provide some historical and contemporary perspectives on how a workforce may be better mobilized to manage manzanitas and limit fire risk.

Figure 3.22. A future of living Manzanita, happy campers and new settlers?



On the left a presentation by Charles F. Ernst in 1939 presented at the conference on governmental problems in San Francisco, entitled "Migrants our potential new settlers" October 26, 1939, Presented at the Western Conference on Governmental Problems, San Francisco California. He writes:

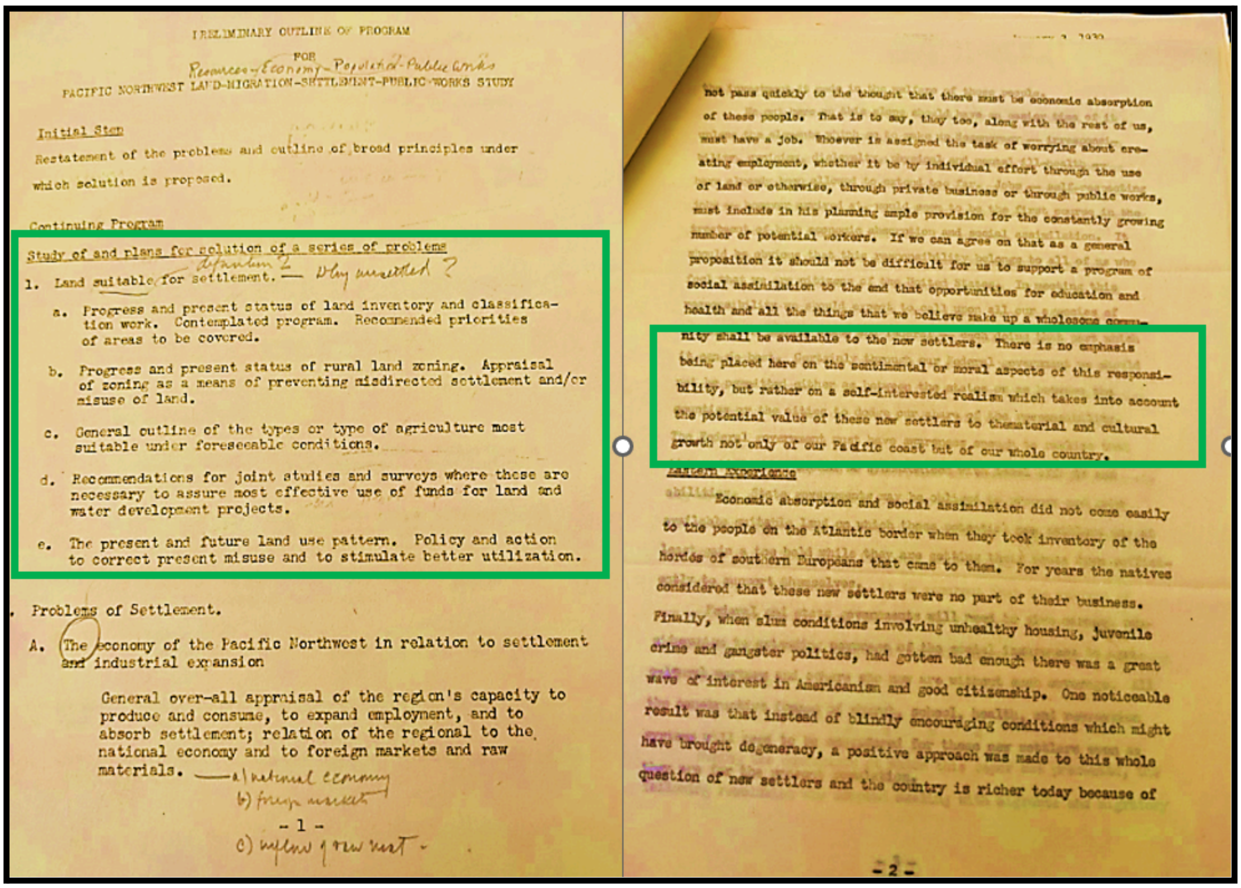
> *"If we consider today questions arising out of the age-old phenomenon of migration it may be interesting to remind ourselves that a generation ago people in the states bordering on the Atlantic were concerned about the problem of immigration…if we are willing to accept this conclusion even on the basis of estimation, should we not arrive at once at the truth that our problem is not so much one of migrants and migratory labor as it is one of new settlers?*

A few decades later the governor of California, Honorable Edmund G Brown, writes a letter to the federal government, October 9, 1964, critiquing a University of California Agricultural labor report that was presented at a conference in Berkeley on "the farm labor problem". He writes…

> *"The final UC report failed to include the alternative section from the preliminary draft which outlined a program of combining wage increases, a young adult recruitment program and the FL414 program until such time as the domestic labor could be developed. Sounds very appealing."*

In the context of Manzanitas rising, this historic problem again resurfaces in the context of incentives and funding for long term landscape management and raises both new and old questions.. Who may be available to engage in such a long-term restoration program? Where will they live? Beyond State parks and public lands where else could restoration efforts happen? Do we have sufficient State Parks and public lands within walking distance of our diverse populations throughout the State? Could we have more State parks and more funding, with more labor over land to minimize fire risk and support long-term stewardship efforts. Perhaps in responding to these lessons and questions from the past we may learn from this discussion of Manzanita rising to reconsider these earlier questions posed as in the margins in figure 3.23 from a Pacific Northwest Land-Migration-Settlement Public Works Study 1939 - land suitable for settlement - Why unsettled?

Figure 3.23. Planning Solutions with Self-Interested Realism of Cultural Growth


PRELIMINARY OUTLINE OF PROGRAM

FOR

PACIFIC NORTHWEST LAND-MIGRATION-SETTLEMENT-PUBLIC-WORKS STUDY

Initial Step

Restatement of the problems and outline of broad principles under which solution is proposed.

Continuing Program

Study of and plans for solution of a series of problems

1. Land suitable for settlement. — Why unsettled ?
   a. Progress and present status of land inventory and classification work. Contemplated program. Recommended priorities of areas to be covered.
   b. Progress and present status of rural land zoning. Appraisal of zoning as a means of preventing misdirected settlement and/or misuse of land.
   c. General outline of the types or type of agriculture most suitable under foreseeable conditions.
   d. Recommendations for joint studies and surveys where these are necessary to assure most effective use of funds for land and water development projects.
   e. The present and future land use pattern. Policy and action to correct present misuse and to stimulate better utilization.

. Problems of Settlement.

A. The economy of the Pacific Northwest in relation to settlement and industrial expansion

General over-all appraisal of the region's capacity to produce and consume, to expand employment, and to absorb settlement; relation of the regional to the national economy and to foreign markets and raw materials.

- 1 -

not pass quickly to the thought that there must be economic absorption of these people. That is to say, they too, along with the rest of us, must have a job. Whoever is assigned the task of worrying about creating employment, whether it be by individual effort through the use of land or otherwise, through private business or through public works, must include in his planning ample provision for the constantly growing number of potential workers. If we can agree on that as a general proposition it should not be difficult for us to support a program of social assimilation to the end that opportunities for education and health and all the things that we believe make up a wholesome community shall be available to the new settlers. There is no emphasis being placed here on the sentimental or moral aspects of this responsibility, but rather on a self-interested realism which takes into account the potential value of these new settlers to thematerial and cultural growth not only of our Pacific coast but of our whole country.

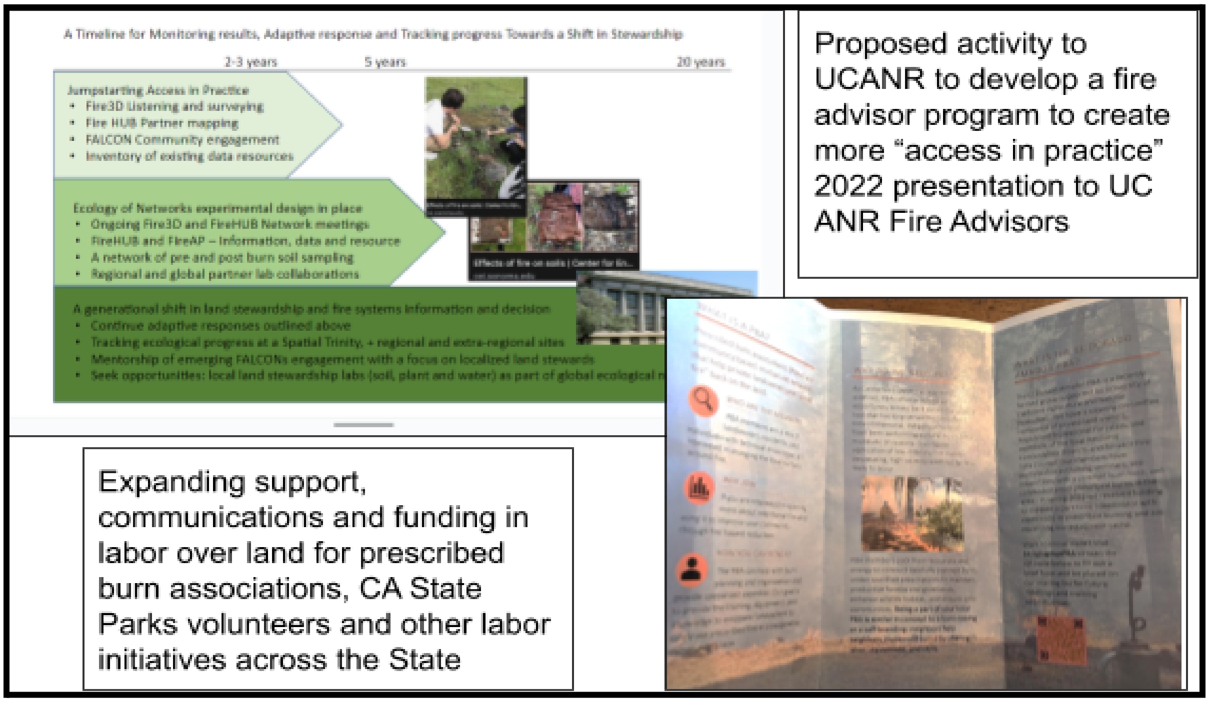
Eastern Experience

Economic absorption and social assimilation did not come easily to the people on the Atlantic border when they took inventory of the hordes of southern Europeans that came to them. For years the natives considered that these new settlers were no part of their business. Finally, when slum conditions involving unhealthy housing, juvenile crime and gangster politics, had gotten bad enough there was a great wave of interest in Americanism and good citizenship. One noticeable result was that instead of blindly encouraging conditions which might have brought degeneracy, a positive approach was made to this whole question of new settlers and the country is richer today because of

- 2 -

Through activities such as prescribed burn associations, expanded vegetation management programs in State parks and public lands and other initiatives such as revisiting proposed youth job creation and training for domestic labor and expanded restoration initiatives through University of California resources as proposed to the University of California Agriculture and Natural Resources team of fire advisors, a more practical landscape restoration, affordable housing and livelihood program can foster further investigation and investing in California's mutual communities in coupled connection with Manzanita's Rising, Figure 3.24.

Figure 3.24. Labor on the Land expanding in community, academic and parks programs



Conclusion: Internalizing Fire: The Politics of Practice with Fire Ecosystems in Flux

As a conclusion to this dissertation on internalizing fire at what cost and scale, an investigation into the interacting histories on land use, migration, labor, wartime food security and industrial technologies in California and across North American landscapes has provided a backdrop to some complex problems that challenge both the complex and simple models of our time. The questions of the transport and movement of labor over land and the interacting technologies and infrastructures that demanded and enabled such choices and decisions are central. The logics of central planning and local impacts have come into question in an age of catastrophic fire over a variegated, diverse and regional ecology that raises some old and new questions on the practices of people, institutions and decision making on the land. As our fire ecosystems are in flux and decision makers grapple with hard choices across resilience, reactivity and variability (Arnoldi, 2015), this dissertation has argued that turning to simple process models may lead to the type of actions better adapted to the moment. With a focus on engaging in a transdisciplinary systems approach to considering movements of labor over the landscape in practice, the logic of having a politics focused more on practice, experimentation and creativity in diverse forms has come into view.

If we turn to some systems and control theory for a framing of complex problems in dynamic systems in flux, borrowing from systems, signals and control theory the role of state variables in this fire on the landscape context of simultaneously interacting variables, may shed some light (Lathi,1974, Signals, systems and control). Rather than a traditional box model with input and outputs, the identification of variables internal to the model or within “the box” may be identified to better formulate the internal workings of the system. In the context of this dissertation the spatial and temporal variability may be isolated as the presence of on site, human interactions and decision on the landscape. Where human decision interacts to adapt to local and environmental conditions in a way that evolves with the external inputs and outputs. Here the state variable internal to such a model is availability of labor on the land and presence of local decision. The decision may constitute a range of vegetation management and land use practices including prescription fire, grazing, mechanized treatment or landscape conversion, etc.). The assumption of such a process model is to create a system at equilibrium that balances local and global factors (i.e. temperature, humidity) to enhance existing effects and provide sustained socioeconomic and ecologically coupled livelihoods, including the availability of cultural resources, such as, recreational amenities, traditional medicinals, a manzanita rising, or catastrophic risk reduction.

On the land, the term prescription burn or prescription fire provides an idea of a team of caregivers providing the type of treatment necessary to remedy the imbalance or systemic failure, or inflammation that has led to an outcome that disrupts what is deemed to be necessary for a functioning landscape. If the approach is constituted by a pre-determination of a specific outcome or the result of a structured planning decision that has determined objectives, akin to the role of the physician in requiring some specific set of results in a scientific analysis or experimental process, yet the patient may have their own thresholds or responses that diverge from the physician's expectation. The landscape may be far more complex than the caregiver, physician, scientist may fully comprehend.

The scale of temporal decision may include approaches needed to provide a restorative, remediative or productive effect on the landscape. In this example, the present treatment a doctor or caregiver will meet with a patient (landscape) considering the present treatment, patient history, and a range of environmental factors. Both the history of the landscape and the history of its boundaries are both ecological and institutional constructions. We may consider these as both internal and external factors leading to the outcomes or the cumulative history of the landscape and interacting elements. Further, these interacting temporal dynamics may create emergence as discussed by Holland and others as generating new levels of organization within confines of the physical sciences (chemical and structural vegetative interactions) (Holland , J. 2014)

This organization also can effect and emerge when coupled with the evolution of sociocultural organization similar to the models of coupled human and natural systems (Li et al. 2011) interactions amid interacting agents and emergent properties and organization. An example of this in the context of this work is the cyclical human interaction or herbivore that may lead to impacts to both above and below ground vegetation, mycelium or fungal and microbial presence and network interactions that can have long term positive and negative interactions with above ground and below ground vegetation, species diversity, richness and soil health and forest health (Fossum et al. 2024).

Primarily, the importance of understanding patient and family history for that matter focuses in on the critical memories or "DNA" of the landscape both long and short term, in which human presence is a requisite in a CHANS framework.That human presence must also have elements of human capital, ability to sense, know and act in decision on landscape management that also has an evolutionary impact and feedback on the evolution of such human decision. For instance the effect that burning may have on olfactory and neurological responses including fear, comfort or digestive systems. In an assumption of Human capital as natural capital the main internal state variable is the creative capacity of human capital and potential rate of learning that is capable in the context of the human mind, frequency of interaction and social organization including regulatory practice. The result is a connection between all living systems in an ecology of the unknown, amid uncertainty and constant variability. How we respond in practice is politics.

Humans have the ability to be at once primordial and highly adaptive, using tools and adaptive command structures that both move from individual to group dynamics simultaneously. Processes of thinking Fast and thinking slow (Kahneman, 2011), movements while fast may be primordial in nature. Movements while slow may allow for the energetic interaction within, as in internalizing fire, and externally coupled with natural interaction or environmental stimulus required in dynamic thinking with cumulative memory and observation. Carney points to the knowledge acquisition of repetitive work, a type of muscle memory in the mechanics of movement and connection to neural pathways and learning.

These processes require learning within the body and experiencing sensory perceptions that are part of our historic selves. Our embodied adaptation whether through DNA or other processes in managing the wind's interaction with its natural state. Choice of technologies and tools may either distract and get in the way of new approaches in management or perhaps inspire a hammer and a nail approach, common in engineered “solutions”.

Many people have divergent perspectives of what they would like to see from the landscape or in the landscape. Sharing perspectives on what objectives they would like to see developed and whether they include these histories, perspectives and “localized risk” in a process of joint decision may be akin to a sinusoidal frequency-response method of synthesis of these fire ecosystems in flux . A question in every process needs to consider the temporal horizon of the variables involved that lead to interacting stimuli (Lathi, 1974).

Systems in flux and the Politics of Practice

The organization of the planning process is an expression of the practice in the field. In a small group of prescribed fire workers there is a trade off between “person power” and availability of labor balanced by the need for technology, tools and resources. Yet these tradeoffs are asymmetric.

The more people available for a given action the more tools and instruction, guidance, safety and protocols and perhaps monitoring that is needed. Communication in the field may also be additionally challenging. Communicating through conflicting objectives or the appropriate place and procedure can take time. A smaller group burn may require fewer points of communication and information flow in the field when faced with the challenge of moving across a landscape in a way that is both methodical and practical, the fewer individuals to coordinate may be the most effective way to meet specific criteria. Both from a perspective of informing, education, safety and execution. On the other hand, environmental factors and the flame length of the moment matters in reducing potential labor time for future burns or vegetation treatment over dynamic time. These and other lessons were learned through the politics of practice.

The Politics of Practice is an approach taken throughout my research which centers the researcher in both the learning behavior and the product. In the literature, participatory processes in academic research are well documented and expanding in recent years. The art of and science of practice in academic environments is continuously evolving and has reflections in the context of labor economics and sociocultural literatures in the context of information and learning environments (Carney, 2001; Foster, 2000) among other disciplines. In participatory and ethnographic research the importance of place and space is foundational to the act of researcher as participant. Yet the actions and practice of the researcher are important in this process if the emphasis is on a conditioning of the subject, as non-extractive. In essence the ability to engage in research alongside learning and knowledge creation.

To make this point I use an example from a field experience while engaging in wildland firefighting certification during a prescribed burn training in Sonoma County, where I reside. The landholder invited volunteers to participate in a shared vegetation clearing exercise and what amounted to - on the day - as a series of pile burns using previously cleared, and managed vegetation of the day's labor. In an opening remarks of the day, the landholder provided a comment on his objectives to returning the landscape to a state where grazing animals may return in larger numbers to a previously overgrown forest ecosystem. “I look forward to the opportunity to hunt again on my land” was the statement, in the process of communicating to the volunteers the desire for a community to help manage the land together for an objective that was possessive and individualized. Through the course of the day this remark lingered in my mind as I used tools and my hands to clear the landscape, saddled by heavy equipment on my back in following administrative wildland fire protocols. After many hours of labor, the work on this landscape in practice felt more like unpaid gardening, yard work and farm labor than a community endeavor to restore habitat and an ecologically functioning landscape that would be accessible to the community. Questions of community participation in sharing the benefits of managing common pool resources resonated with me that day.

The benefits to training and public private partnerships in land management to manage fire risks are many and varied, requiring perspectives on liability, property ownership type, the productivity of the land and the culture and practice of politics of community building for which land holders may choose to be responsive.

The Politics of Practice in Restoring a Process: Learning in Academic institutions and fostering Adaptive Knowledge Systems

My learned experience over the years of my graduate work engaging with dialogues concerning fire and energy systems provided some unique observations into the functioning of academic institutions in basic assumptions at the interface of climate change, land use and institutional access to diverse perspectives in the academy. The most significant example of this was an interview with the Chair of the Energy and Resources Group at the University of California Berkeley, in the Fall of 2022 over a discussion of the Labor over Land model presented in Chapter 2 of my dissertation. When presented with the concept of the model and base assumptions of free movement and individual choice of best available transport technologies over the landscape, in a business as usual, and potential repopulation or "settlement" scenario of "retending the wild" - as has been discussed throughout these chapters of labor connected to landscapes - the response I received was neither open minded, constructive nor practical.

The Chair of the department asked why I would not instead do a full electric and urbanized system scenario, I replied that I do not believe a global full electric vehicle future is either practical or realistic given the embedded carbon, earth minerals limitations, materials flows, environmental and labor externalities required in build out, and then continued long term global emissions of an all electric transformation as he requested. Plus it would not fix the fire and landscape challenge which is the core focus of my work. Rather, some electric vehicles and a mix of other traditional vehicles and modes of transport currently available would be more practical along with some relocation and resettlement of currently unpopulated areas to manage the landscape. The Chair replied that repopulating the landscape was unrealistic. My response to the Chair was that I have never seen a full lifecycle analysis of the approach that he was referring to and I asked him how he planned to acquire all the needed battery and clean energy materials for that type and scale of global transformation, his response was that they would be obtained from "extraplanetary sources". I asked him which planet he was planning to travel to?

Perhaps his unrelenting belief in the imaginary or science fiction inspired his comment, when in fact few of the technologies and materials required to do what he suggested are available today. Additional challenges of the current knowledge of the laws of physics provide other obstacles. Yet, his claim was that such a scenario was more realistic than moving people (labor) over the landscape. Perhaps other obstacles to learning and a politics of practice exist for the chair of the department as well?

The option I proposed is the option I presented in the chapters of the dissertation where people would work with the transport options of the time or that exist today and potentially settle on the land where they work, mirroring my own practical and lived experience. Likely, others have this knowledge as well.

As we are seeing today, private developers, land holders, non-profits and individuals are engaged in activities to consider differing modes of repopulating unsettled spaces, whether its van life, off grid, home-steading, microgrid communities (Lawrence, 2023), mobile tiny homes, building an accessory dwelling unit, or large proposals like in California's Solano County by the development initiative "California Forever" to turn intensive farm land over to a "sustainable" residential township landscape (Dineen, 2024), or alternatively for an individual or community to buy a farm and ranchland and restore indigenous materials gathering and community spaces for all, like in the newly developed Dos Rios California State Park in the Central Valley opened in 2024 (Mehta, 2024).

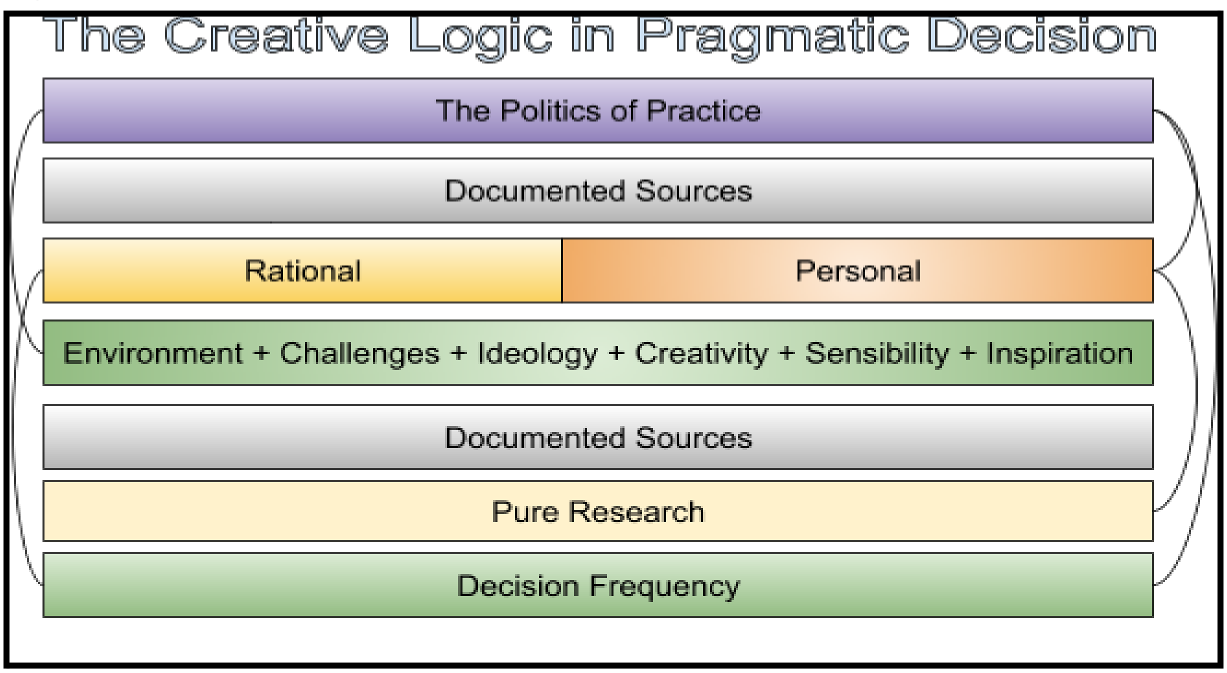
In this dissertation, the Politics of Practice embedded in a theory of transport and economic geography constitutes the frame and area from which we explore the importance of human agency. As people begin to further explore their roles in their communities from an early age it is important that we consider how peoples framework evolves, some people may tend to take a direct view of their relationships with others that may lose some subtleties related to the slower and authentic interpretations and dialogues of movements and relationships within human and connected ecological experience. Regardless, the continuous and regional dialogues required of an earth system response may benefit from learning from experience elsewhere, one example as instituted in the French "Schema de Coherence Territoriale (SCOT) et d´eveloppement durable en France" documented in Moscarelli's work at the University of Montpellier 2013, outlines some decision spaces that I have adapted and integrate into this conclusion and my approach to a Politics of Practice in adaptive systems.

The Politics of Practice in Adaptive Systems

As part of the schema developed in the French government's response to climate change the SCOT program develops mechanisms and theory for the frequent negotiations between multi-scaled representative governments from the commune level to the National government in a series of frequent and mandated negotiations between regions focused on structuring sustainable development goals. As part of this process Moscarelli outlines some decision making features of the schematic as the modes of practice and operation of the program as I have adapted below, with some modification to system flows in the context of an interpretation of the Politics of Practice and frequency of decision.

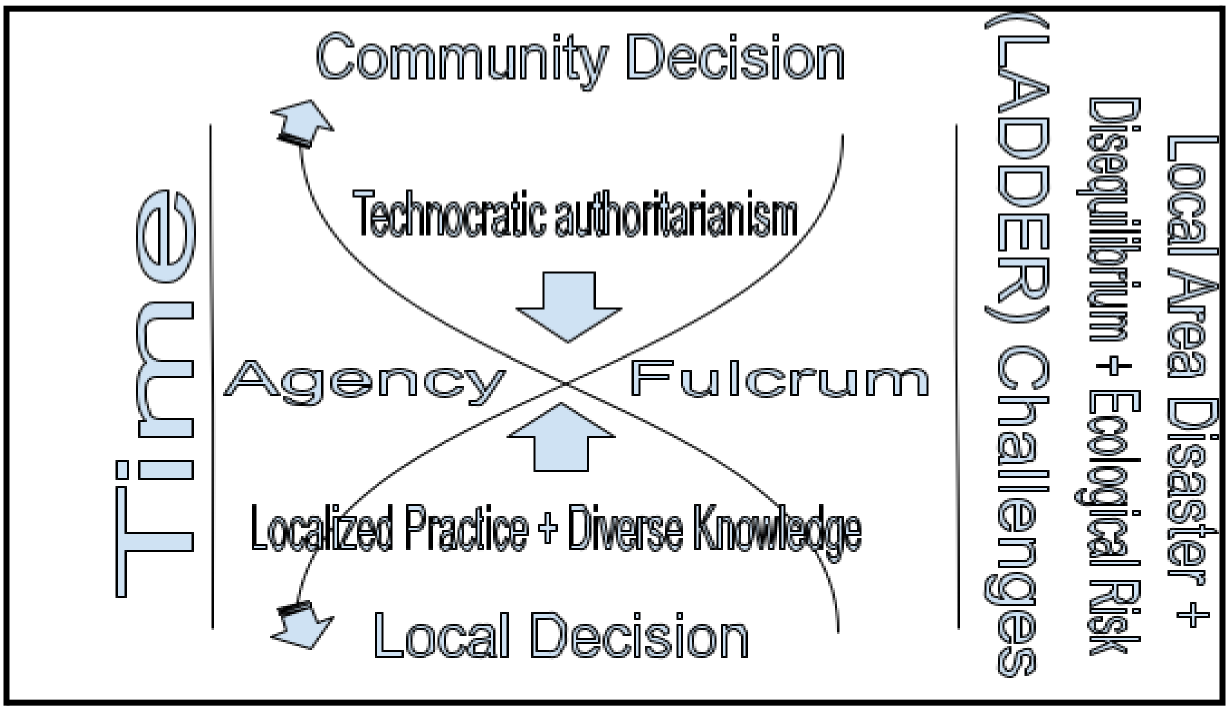
As the saying goes all politics is local, yet further to that all politics is personal, made of both rational and sensorial responses that factor in background environment, awareness of immediate and long term challenges, previously held beliefs, creativity, sensibility and inspiration to act. Moscarelli argues that the interaction of research, documented sources and the ways of rational and personal knowledge are important in democratic decision making and the objectives of sustainable development. The adapted schema in C1 developed here focuses on the interplay between decision frequency in the context of the rational and personal in the pursuit of pure research and knowledge creation that underpins the personal response to the Politics of Practice. While there are linkages throughout, the frequency of personal or rather local development and pure research integrated into a Politics of Practice creates the mechanism for creative decision, akin to learning by doing.

Figure C1. Adaptation of the Politics of Practice from Moscarelli SCOT schema



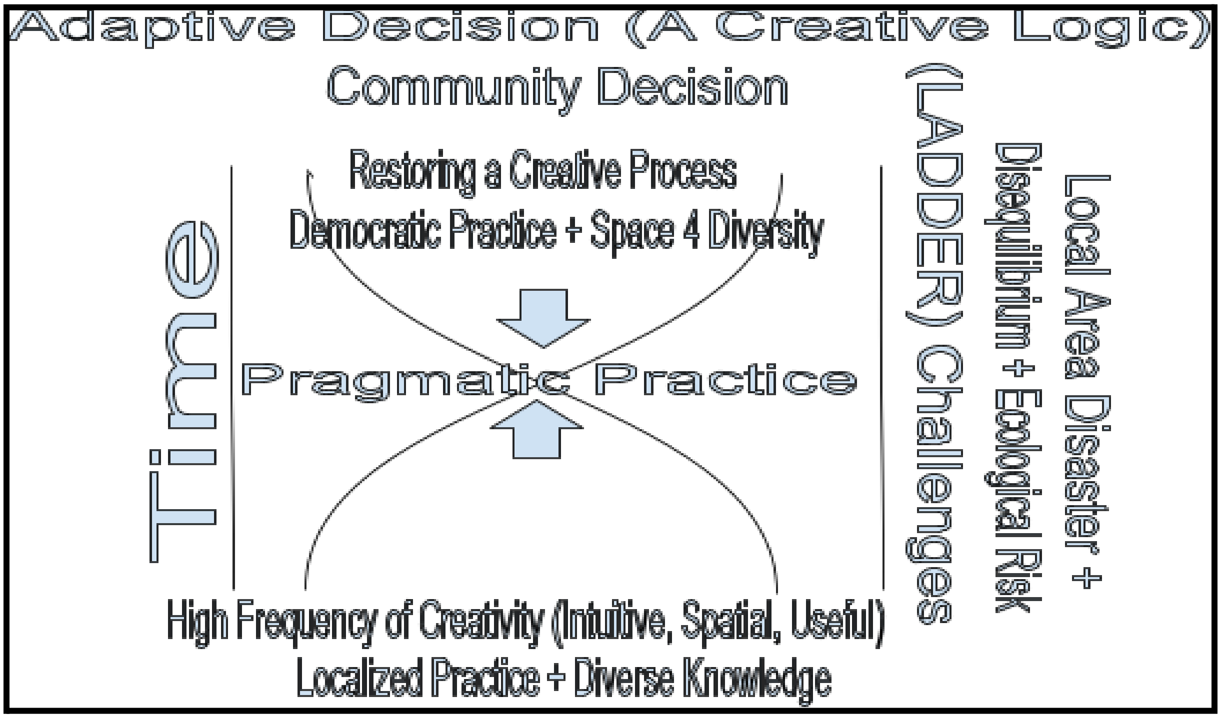
Now turning to response to catastrophic fire in a community decision, as outlined in the below figure, local decision and community decision, when faced with local area disaster and the disequilibrium states of ecological risk are formulated over a sequence of decisions. The decisions over time respond to the push and pull of factors of the rational and personal in local and community decisions. The degree or flow of human agency exists at the point of contradiction between local practice and integration of diverse knowledge in a learning environment confronted with technocratic authoritarianism, or rather majority will.

Figure C2. Contradictions over time in the face of LADDER Challenges



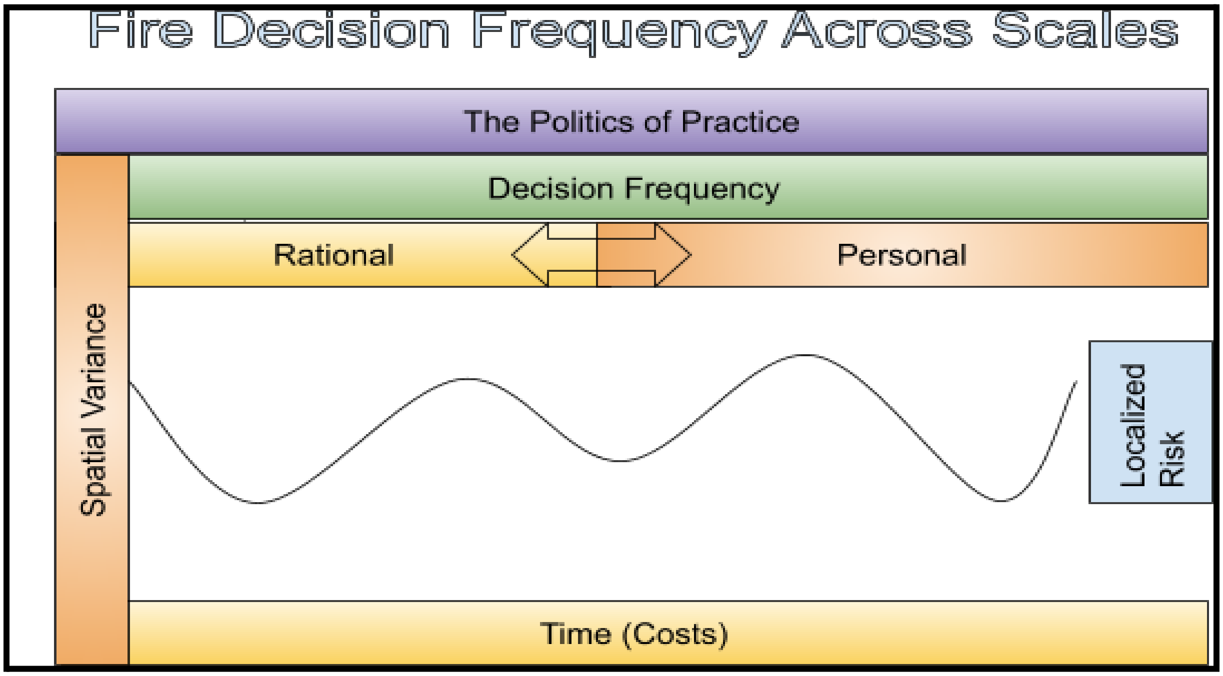
As the decision space in adaptive decision focuses on pragmatic practice and fostering greater agency through a community and cycles of democratic decision making, space is made for diversity and creative logics that foster intuitive, spatially relevant and useful decision and action. Here localized practices and diverse knowledges are better situated to inform community decisions in the face of LADDER challenges (Figure C3).

Figure C3. Fostering a creative logic in community decision



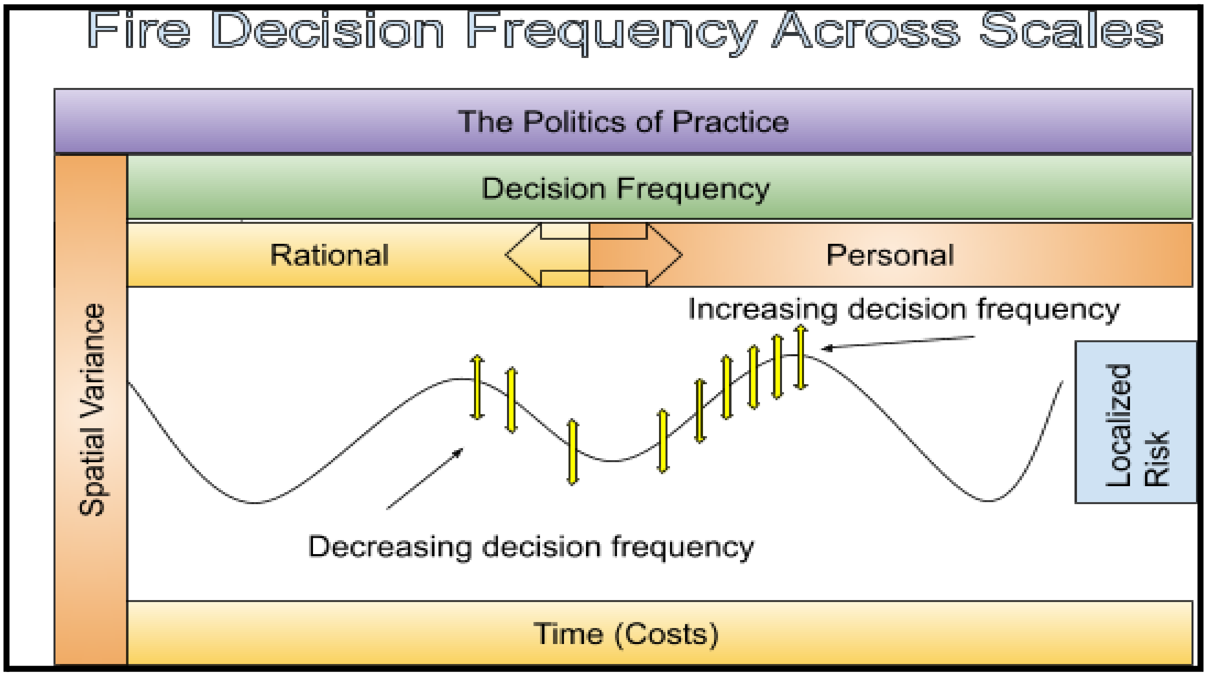
In this decision framework The politics of practice at an institutional level is impacted by the real (rational) and the perceived risk and the personal (or actionable operation space). With relevant costs factored by time allocation for decision and the practices that are directly impacted by the spatial variance (i.e. situational awareness, transport, presence, absence) of the challenge or problem space. Here the spatial variance of a particular event either planned or stochastic, for instance, a plan to practice prescribed burning or response to an incidence of fire, oscillates with the frequency of decision at each time step Figure C4.

Figure C4. Localized risk as a factor of Fire Decision frequency across Scales



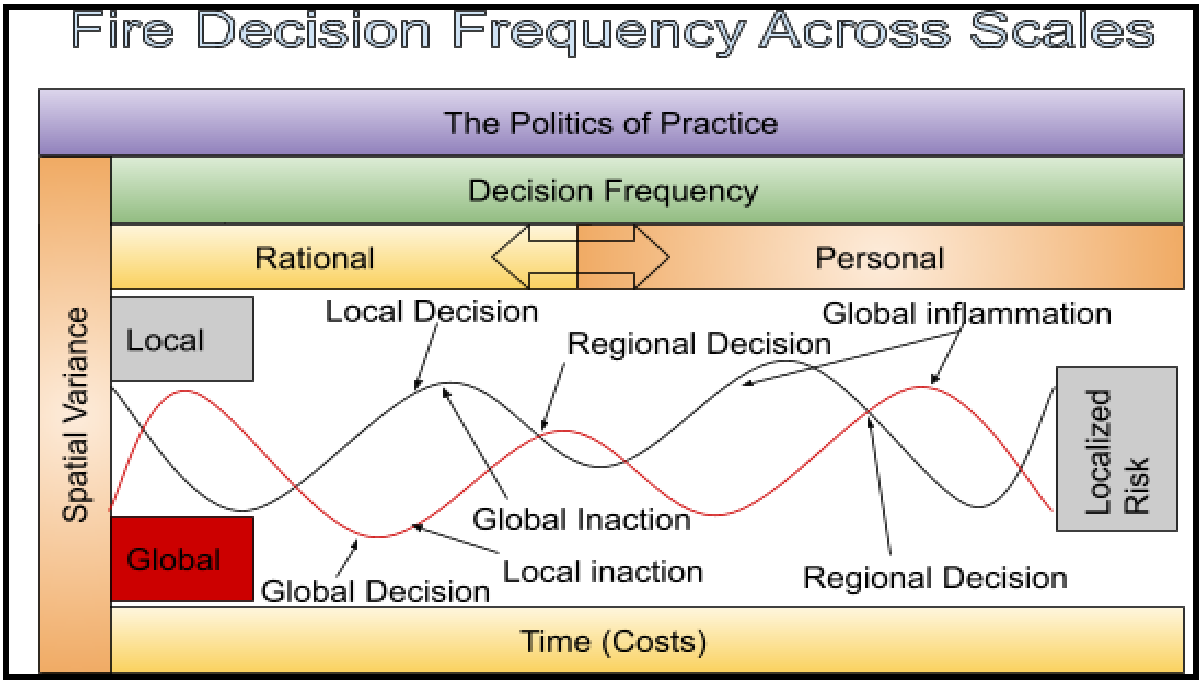
Additionally, resource (labor, technology, material) availability changes with the spatial variance of the problem and the scale of the decision in time. Over time as the perception of localized risk increases, the frequency of decision will increase and likewise as the localized risk decreases the frequency of the decision will likely decrease. It's important to note in this context that regardless if the actual LADDER risk has increased or not, it is the perception of that risk (i.e. situational awareness) in a politics of practice that is referred to as localized risk, Figure C5. In this context, it is likely that more frequent decisions may also lead to an expanded situational awareness that in practice has a positive feedback with the knowledge of and amplitude of localized risk.

Figure C5. As localized risk increases the decision frequency increases



Finally, as this frequency of decision is used in something like the framework suggested in the French SCOT system that may be applied or adapted to management in other regions, the questions relevant to global climate change, the impact on localized risk of fire and in essence the process of internalizing fire at a global and local level come into play in this final frame of this dissertation focusing on the space for regional decision, Figure C6.

Figure C6. Internalizing fire with a space for regional decision and Politics in Practice



As the spatial variance of LADDER risk oscillates from densities at a global to local level the periodicity of decision will fluctuate over time between moments when localized risk spurs prompt local decision or when LADDER risks impacting another part of the Earth system are less recognized at a local level leading to less frequent decision or indecision in the face of global challenges, however real, that have not been localized. In the context of global inflammation, localized risk would be high for all and the frequency of local and global decisions would be high (Similar to the global and local fire situations experienced in recent years). The theoretical schematic points two two patterns of global fire that interact across spatial variance, one as a metric of a wave form reflecting global conflagrations and the other as a metric of a specific location related to localized risk. Based on this model the point at which the localized risk of global conflagration and local conflagration coincide may be optimal for regional dialogues on decision making with both localized risk realized on a local and global wavelength.

As year round temperatures rise and the high heat days increase in frequency, finding more windows to engage in prescribed fire at the right time that the criteria for a burn will work requires more creative thinking about “fuel readiness, crew availability, weather and ecological conditions.” As figure C7 discusses, the dry summer months, while seemingly counterintuitive , often provide the necessary conditions for effective burns." In this context, a year round, not just seasonal, labor force is a necessary condition.

Figure C7. Balancinging Wildfire and LADDER risks? Year round frequency matters..

Why prescribed burns in summer? How to balance wildfire mitigation

By Roger Coryell

As Sonoma County grapples with an increasingly intense wildfire season, the use of prescribed burns becomes a central topic of discussion. While the recent Point Fire in Dry Creek Valley is not linked to a controlled burn, it heightens concerns and brings the practice under scrutiny.

A 2024 study led by Christina Fossum of UC Berkeley finds that prescribed burning is critical for mitigating the impacts of wildfire across California, especially as increasing wildfire activity strains suppression resources.

Wendy Coy of Audubon Canyon Ranch's Fire Forward program in Glen Ellen emphasizes that prescribed burns are not solely confined to summer. "They can be done any time of year, depending on fuel readiness, crew availability, weather and ecological goals."

However, the dry summer months, while seemingly counterintuitive, often provide the necessary conditions for effective burns. The Fire Forward program provides training for prescribed burns.

The need for dry fuel

"Broadcast burns require dry fuel, typically less than 12% moisture content," Coy explains. This low moisture level allows for rapid combustion and minimal smoke production, critical for both safety and achieving ecological benefits. While smaller brush piles can be burned in winter, larger areas require the drier conditions often found in summer.

Interestingly, the UC Berkeley study observes an increase in summer burn day opportunities in Sonoma County over the past 23 years, especially in the northern part of the county.

Addressing safety concerns

Despite the inherent risks of burning during the dry season, Coy assures that extensive safety measures are in place. "Preparatory work includes control lines, fuel breaks, tree limbing and close weather monitoring," she explains. Detailed burn plans are also developed and approved by Cal Fire and local authorities, ensuring compliance with safety regulations.

However, the study authors note that resource availability during wildfire season and air quality regulations in winter can constrain prescribed burning. Addressing these constraints is key to expanding its use.

Ecological benefits of summer burns

Beyond wildfire prevention, summer burns offer ecological advantages. Coy highlights their positive impact on oak woodlands and grasslands, improving acorn production, controlling invasive species and enhancing habitat for wildlife. These burns contribute to overall forest health by reducing fuel loads and promoting biodiversity.

The UC Berkeley study supports this, finding increased burn day opportunities in forests and shrublands in Sonoma County, suggesting prescribed fire could help restore coastal grasslands and wildlife habitat.

Public outreach and education

Addressing public concerns and educating communities about the benefits of prescribed burns is a crucial aspect of Audubon Canyon Ranch's work. Coy emphasizes proactive communication through press releases, social media, community events and educational resources like their smoke alert sign-up form.

The study authors also highlight the practical relevance of their findings for informing prescribed fire policy and decision-making at the county and state level.

As communities grapple with the increasing threat of wildfires, understanding the role of prescribed burns becomes essential. The UC Berkeley study concludes that expanding beneficial fire use in California requires changes to current practices, including restructuring operational capacity, increasing flexibility for fire practitioners and empowering local and indigenous knowledge in stewarding landscapes. By balancing caution with strategic action, these controlled burns can be a valuable tool in protecting both lives and the environment.

THE SONOMA COUNTY LIBRARY
kanopy
THOUGHTFUL ENTERTAINMENT
Streaming collection showcasing 30,000+ classic and indie films

Source: Coryell, July 2024 - sonomacountygazzette.com

As the Fossum study suggests burning at different frequencies or times of day, and times of year, may provide the opportunities necessary for a more balanced wildfire and global biomass combustion scenario. The study notes that "resource availability during wildfire season and air quality regulations in winter can constrain prescribed burning, addressing these concerns is ket to expanding its use." As the science and politics of prescribed fire and climate adaptation come into focus "changes to current practices, including restructuring operational capacity, increasing flexibility…and empowering local and indigenous knowledge in stewarding landscapes" is practically relevant at the county and State and - dare I say - regional scale.

In a Politics of Practice of Internalizing Fire, such regional dialogues as venues for decision coupled with increased global and local dialogues, akin to the example of SCOT, may provide a more ecologically sound sharing of knowledge that is more transboundary and provides for more creative, actionable and practical decisions. Today, as people move and migrate through a wide means of transport options, the majority of the planet is still using our feet most frequently, Making decisions each step of the way on how to make space for ourselves while making space for others. Walking or manually rolling are some great traditional and contemporary ways to move our own labor over the land. Not only are they least cost options in building global wellness and health, they are also a practice that is necessary in both internalizing fire (i.e. eating) in the city and where land needs in the countryside provide essential services while tending to produce multiple global benefits.

References and Bibliography:

Introduction

Agnew, J. (1994). The Territorial Trap: The Geographical Assumptions of International Relations Theory. Review of International Political Economy, 1(1), 53–80.

Agnew, J.A. (2013) Arguing with Regions, Regional Studies, 47:1, 6-17

Anderson, M. K. (2005) Tending the Wild: Native American Knowledge and the Management of California's Natural Resources Journal of California and Great Basin Anthropology.

Berck, Peter (1999) Why are the Uses Multiple? Multiple Use of Forests and Other Natural Resources, Volume 61 of the series Forestry Sciences pp 3-13

Berkes, F., and C. Folke. (1998) Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge University Press, New York, New York, USA.

Biswell, H. (1999) Prescribed Burning in California Wildlands Vegetation Management. University of California Press.

Chang, Gordon H. Ghosts of Gold Mountain: The Epic Story of the Chinese Who Built the Transcontinental Railroad. 2019.

Diamond, Jared M. (2005). Guns, germs, and steel : the fates of human societies. New York :Norton.

Ehrlich, P. Bilderback, L. Ehrlich, A. (1979) The Golden Door: International Migration, Mexico, and the United States.

Graeber, D., & Wengrow, D. (2023). The dawn of everything: a new history of humanity. First paperback edition. New York, Picador.

Howitt, R. & Lunkapis, Gaim. (2010), Coexistence: Planning and the challenge of indigenous rights.

Laurie, Bruce (1997) Artisans into Workers: Labor in Nineteenth-Century America. 1997.

Mazoyer, Marcel and Roudart, Laurence (2006) A History of World Agriculture: From the Neolithic Age to the Current Crisis. Monthly Review Press New York.

Mcwilliams, Carey (1935) Factories in the Field: The Story of Migratory Farm Labor in California, University of California Press

Ostrom, Elinor (1990) Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, UK. Chapter 3. Analyzing long enduring self-organized collective CDRs

Ostrom, Elinor (2005) Understanding Institutional Diversity. Princeton University Press, Princeton, NJ.

Polanyi, K. (1944, 1957, 2001) The Great Transformation. Beacon Press, Boston Mass. The Self Regulating Market and the Fictitious Commodities - Labor, Land and Money.

Pyne, Stephen J. (1997) Vestal Fire: An Environmental History Told through Fire, of Europe and Europe's Encounter with the World. University of Washington Press.

Pyne, S. J. (2001). Fire: A Brief History. University of Washington Press.

Pyne, Stephen (2016) California: A Fire Survey (2016), Tucson: University of Arizona Press, 2016.

Reséndez, A. (2016). The other slavery: the uncovered story of Indian enslavement in America. Boston; New York, Houghton Mifflin Harcourt.

Sauer, C. O. (1963) Land and Life, A Selection from the Writings of Carl Ortwin Sauer. Edited by John Leighly. University of California Press, Berkeley and Los Angeles.

Stephens, S. L. and Ruth, W. (2005) Federal forest-fire policy in the United States. Ecological Applications, 15(2), 532-542.

Stephens, Scott L., Hall, Les, Stephens, Connor W. Bernal, Alexis A. and Collins, Brandon M. (2023) Degradation and restoration of Indigenous California black oak (Quercus kelloggii) stands in the northern Sierra Nevada Stephens et al. Fire Ecology (2023) 19:12

Stewart, O Edited by Anderson K. (2002) Forgotten Fires, Native Americans and the Transient Wilderness. University of Oklahoma Press.

Westerling, A. (2008) Climate and Wildfire in the Western United States. UC Merced Press

Vallejo Papers, Bancroft Library Special Collections, University of California Berkeley

Chapter 1- Bracero Burning

Agnew, J. (1994). The Territorial Trap: The Geographical Assumptions of International Relations Theory. Review of International Political Economy, 1(1), 53–80. http://www.jstor.org/stable/4177090

Agnew, J.A. (2013) Arguing with Regions, Regional Studies, 47:1, 6-17

Agrawal, A. & E. Ostrom. 2008. "Decentralization and Community-Based Forestry: Learning from Experience." In Decentralization, Forests and Rural Communities: Policy Outcomes in South and Southeast Asia. E.L. Webb & G.P. Shivakoti, eds. Los Angeles, CA: SAGE Publications.

Alexander, Rani T. (2019) Technology and Tradition in Mesoamerica after the Spanish Invasion – Archaeological Perspectives, University of New Mexico Press, Albuquerque.

Aldridge, Karl. Papers, Stanford Library Special Collections.

Anderson, M. K. (2005) Tending the Wild: Native American Knowledge and the Management of California's Natural Resources Journal of California and Great Basin Anthropology.

Azuma, Elchiro, (2005) Between Two Empires: Race, History, and Transnationalism in Japanese America. 2005, Chapter 8.

Baran, Robert, J. (Last updated April 16, 2022) ://www.magiminiland.org/BigPicture/Internment.html;

Best, D. V. (2021) "Bracero Burning: Towards an Ecology of Integrated Systems of Fire." Presentation at American Association of Geographers, April 2021.Seattle, WA (virtual).

Best, D.V. and Giardine, F. (2020) Sustainable Energy and Localized Futures an INDI-GIS Approach. California Energy Commission EPIC Funded Project Website. Accessed on 11/06/2020 https://sites.google.com/berkeley.edu/self-indi-gis/self-indi-gis-project-overview

Best, D. V. (2019) Wildfire, Forest and Energy System Resilience: Critical Drivers and Values at Risk to Electricity Reliability and Ecological Security, Presentation at INRA Seminar - Toulouse, France

Best, D.V. (2019) Framing the Scale of Adaptive Management in Socio-Ecological Coupled Systems; Part 1: Interdependent Security: A Dialogue of the Chihuahuan Spruce, Human Ecology and Political Economy at the Borderlands. Presented as Geography 298 at UC Berkeley 12/2019

Bender, Daniel E.r and Lipman, Jana K. eds., (2015) Making the Empire Work: Labor *and United States Imperialism. 2015.*

Berck, Peter (1999) Why are the Uses Multiple? Multiple Use of Forests and Other Natural Resources, Volume 61 of the series Forestry Sciences pp 3-13

Berkes, F., and C. Folke. (1998) Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge University Press, New York, New York, USA.

Berkes, F. (2008) Sacred ecology: traditional ecological knowledge and resource management. 2nd edition. Taylor & Francis, Philadelphia, USA.

Berkes, F., J. Colding, and C. Folke. (2000) Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications. 10(5):1251-1262

Bettinger, P. (2015) Integrating Forestry in Land Use Planning, Current Forestry Rep.

Biswell, H. (1999) Prescribed Burning in California Wildlands Vegetation Management. University of California Press

Bracero History Archive (2020) a project of the Roy Rosenzweig Center for History and New Media, George Mason University, the Smithsonian National Museum of American History, Brown University, and The Institute of Oral History at the University of Texas at El Paso.

Brandt, C.S. (1966) Agricultural Burning, Journal of the Air Pollution Control Association, 16:2, 85-86, DOI: 10.1080/00022470.1966.10468447

Bowman D, Balch J, Artaxo P, Bond WJ, Cochrane MA, D'Antonio C.M. (2011) The human dimension of fire regimes on Earth. J Biogeography. 2011; 38: 2223–2236. PMID: 22279247

Bean, Lowell John; Lawton, Harry W. 1973. Some explanations for the rise of cultural complexity in native California with comments on proto-agricultural and agricultural. In: Lewis, Henry T., author; Bean, Lowell John, ed. Patterns of Indian burning in California: Ecology and ethnohistory. Ramona, CA: Ballena Press

Garner, William Robert, (1970) Letters from California, 1846-1847 University of California Press, 1970.

Timbrook, J. (1982) Vegetation Burning by the Chumash. Journal of California and Great Basin Anthropology. Vol. 4, No. 2, pp. 163-186 (1982).

Campo, J. (1997) Pulses of Soil phosphorous availability in a Mexican tropical dry forest: effects of seasonality and level of wetting.

Carney, J. (2001) Black Rice: The African Origins of Rice Cultivation in the Americas. Harvard University Press.

Chang, Gordon H. (2019) Ghosts of Gold Mountain: The Epic Story of the Chinese Who Built the Transcontinental Railroad.

Cohen, Deborah (2011) Braceros: Migrant Citizens and Transnational Subjects in the Postwar United States and Mexico. 2011.

Cohen, Lizabeth (1990) Making a New Deal: Industrial Workers in Chicago, 1919-1939. 1990.

Coop et al. (2020) Wildfire Driven Forest Conversion in Western North American Landscapes

Cullenward, D. and Victor, D (2021) Making Climate Policy Work. Stanford Press.

Dartt-Newton, D. and Erlandson, J. (2006) Little Choice for the Chumash: Colonialism, Cattle, and Coercion in Mission Period California, American Indian Quarterly, Vol. 30, No. 3/4, Special Issue: Decolonizing Archaeology, University of Nebraska Press

Darques, Regis (2015) Mediterranean cities under fire. A critical approach to the wildland-urban interface. Applied Geography.

Dana, S.T. and Krueger M. (1958) California Lands, Ownership, Use and Management. The American Forestry Association.

Dearinger, Ryan (2016) The Filth of Progress: Immigrants, Americans, and the Building of Canals and Railroads in the West.

Diamond, Jared M. (2005). Guns, germs, and steel : the fates of human societies. New York :Norton,

Ehrlich, P. Bilderback, L. Ehrlich, A. (1979) The Golden Door: International Migration, Mexico, and the United States.

Espindola et al (2017) Social Factors of Land Use and Vegetation Related to Forest Fires in Hidalgo State. Revista Mexicana De Sciencias Forestales.

Fages (1972) Crespi Expedition of 1772 (Pleasanton: Amador-Livermore Historical Society).

Fisher, C., Pollard, H. and Frederick, C. (1999) Intensive agriculture and socio-political development in the Lake Patzcuaro Basin, Michoacan, Mexico. Antiquity, 73, 281; ProQuest pg. 642

Flores, Lori A. (2016) Grounds for Dreaming: Mexican Americans, Mexican Immigrants, and the California Farmworker Movement.

Frazier, D. (1998) The United States and Mexico at War: Nineteenth Century Expansionism and Conflict.

Fulé, P.Z. y Covington (1999) Fire regime changes in La Michilia Biosphere Reserve, Durango Mexico, Conservation Biology, 13(3) 640-652

Fulé, P.Z, Ramos Gomez, M, Cortes-Montano, C and Miller A. M. (2011) Fire regime in Mexican forest under indigenous resource management. Ecological Applications, 21(3) 764-775.

Gibson, Charles (1964) The Aztecs Under Spanish Rule A History of the Indians of the Valley of Mexico, 1519-1810. Stanford Press.

Guerin-Gonzales, Camille, (1996) Mexican Workers and American Dreams: Immigration, Repatriation, and California Farm Labor, 1900-1939. 1996.

González Rosales, A. y Rodríguez Trejo, D.A. 2004. Efecto del chamuscado de copa en el crecimiento en diámetro de Pinus hartwegii. Agrociencia 38(5): 537-544.

Graeber, D. and Wengrow D. (2021) The Dawn of Everything: A New History of Humanity. 2021. Farrar, Straus, and Giroux, New York

Grove, Wayne A. (1996) The Mexican Farm Labor Program, 1942-1964: Government-Administered Labor Market Insurance for Farmers. Agricultural History, Vol. 70,

Hart, Richard, E. Across Boundaries: Transborder Interaction in Comparative Perspective, Western Historical Quarterly, Volume 19, Issue 1, January 1988, Page 89,

Helms, J.A. (1979) Positive effects of prescribed burning on wildfire intensities. Fire Management Notes. 40(3): 10-13.

Herrera, Luis Alfonso (2010) Historias de braceros: olvido y abandono en el norte de México. El Centro de Estudios y Cooperación para América Latina (CECAL)

Hirota, H, (2017) Expelling the poor: Atlantic Seaboard states and the nineteenth-century origins of American immigration policy. Oxford University Press.

Holling, C. (1978). Adaptive environmental assessment and management (p. 377). Chichester: John Wiley.

Howard, R. W. (1962) The Great Iron Trail: The Story of the First Transcontinental Railroad. Putnam's Sons, New York.

Jacoby E. H in collaboration with Jacoby C.F. (1971) Man and Land: The Fundamental Issue in Development. Knopf, Deutsch.

Janssen, M. and Ostrom, E. (2006) Governing Social-Ecological Systems. Chapter 30 in Handbook of Computational Economics, 2006, vol. 2, pp 1465-1509 from Elsevier

Johnson, E.M. (2014) Fire Over Ahwahnee: John Muir and the Decline of Yosemite.

Knight, R.L and Landres, P. (1998) Stewardship Across Boundaries. Island Press

Kurata, T. (2013) Farming with Fire: Revaluing a Japanese Agricultural Tradition. Research Institute for Humanity and Nature.

Lake, Frank K.; Parrotta, John; Giardina, Christian P.; Davidson-Hunt, Iain; Uprety, Yadav. (2018) Integration of Traditional and Western knowledge in forest landscape restoration. In: Mansourian, S., Parrotta, J., eds. Forest Landscape Restoration: Integrated approaches to support effective implementation. New York: Routledge: 198-226. Chapter 12.

Laurie, Bruce (1997) Artisans into Workers: Labor in Nineteenth-Century America. 1997.

Lebaron, Gaye (2019) 'Braceros' helped save Sonoma County crops during World War II. The Press Democrat. September 6, 2019.

Lowe, J. (2021). Breathing fire: female inmate firefighters on the front lines of California's wildfires. First edition. New York, MCD / Farrar, Straus and Giroux.

Lowell, L.B. (1999) Foreign Temporary Workers in America, Policies that Benefit the U.S. Economy. Quorum Books.

Loza, Mireya (2016) Defiant Bracero: How Migrant Workers Fought for Racial, Sexual, and Political Freedom.

Lydon, S. (1985) Chinese Gold: The Chinese in the Monterey Bay Region, Capitola Book Company.

Mapes, Kathleen (2009) Sweet Tranny: Migrant Labor, Industrial Agriculture, and Imperial Politics.

Martinez-Matsuda, Veronia (2020) Migrant Citizenship: Race, Rights, and Reform in the U.S. Farm Labor Camp Program.

Martinez, D. "Daniel Martinez (1958) Thesis, "The Impact of the Bracero Programs on a Southern California Mexican American Community: A Field Study of Cucamonga, *California", pub. 1958 ," in Bracero History Archive, Item #3184, http://braceroarchive.org/items/show/3184 (accessed December 3, 2020).*

Martinez Torres, H. L. (2018) Uso y Manejo Del Fuego Por Comunidades Rurales En Bosques De Coniferas En La Reserva De La Biosfera Mariposa Monarca, Mexico. Doctoral Thesis, Universidad Nacional Autonoma de Mexico (UNAM)

Massey, D. S., Alarcón, R., Durand, J., & González, H. (1987). Return to Aztlan: The Social Process of International Migration from Western Mexico. University of California Press. http://www.jstor.org/stable/10.1525/j.ctt1ppp3j

Mazoyer, Marcel and Roudart, Laurence (2006) A History of World Agriculture: From the Neolithic Age to the Current Crisis. Monthly Review Press New York.

Mcwilliams, Carey (1935) Factories in the Field: The Story of Migratory Farm Labor in California, University of California Press

Mcnary, L.K. (1931) California Spanish and Indian Place Names. Wetzel Publishing, Los Angeles.

Mora, j. (1949) Californios, the Saga of the Hard-riding Vaqueros, America's first Cowboys. Double Day and Company.

Moritz, M.et al. (2014) Learning to coexist with wildfire. Nature

Mumford, Lewis (1959) How War Began. Saturday Evening Post. Carl Sauer Papers, University of California, Berkeley, Bancroft Library.

Nakano Glenn, Evelyn (2002) Unequal Freedom: How Race and Gender Shaped American Citizenship and Labor.

Ngai, Mae M. (2004) Impossible Subjects: Illegal Aliens and the Making of Modern America. Princeton University Press.

Olvera, Silvia Limón. "Fire Deities." In David Carrasco (ed). In The Oxford Encyclopedia of Mesoamerican Cultures. : Oxford University Press, 2001. ISBN 9780195188431. OLCL 1169898498

Ostrom, Elinor (1990) Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, UK. Chapter 3. Analyzing long enduring self-organized collective CDRs

Ostrom, Elinor (2005) Understanding Institutional Diversity. Princeton University Press, Princeton, NJ.

Polanyi, K. (1944, 1957, 2001) The Great Transformation. Beacon Press, Boston Mass. The Self Regulating Market and the Fictitious Commodities - Labor, Land and Money

Pyne, Stephen (2015) Between Two Fires: A Fire History of Contemporary America, Tucson: University of Arizona Press.

Pyne, Stephen (2016) California: A Fire Survey (2016), Tucson: University of Arizona Press, 2016.

Pyne, Stephen J. (1997) Vestal Fire: An Environmental History Told through Fire, of Europe and Europe's Encounter with the World. University of Washington Press.

QGIS.org (1997-2024). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.org

Quintana, Maria, L (2002), Contracting Freedom: Race, Empire, and U.S. Guestworker Programs.

Reséndez, A. (2016). The other slavery: the uncovered story of Indian enslavement in America. Boston; New York, Houghton Mifflin Harcourt.

Rodriguez-Trejo, D. et al. (2011) The Present Status of fire ecology, traditional use of fire, and fire management in Mexico and Central America. Fire Ecology, 7(1) 40-56.

Rodriguez-Trejo, D.A. (2015). Incendios de Vegetacion, su ecologia, manejo e historia (Vol. 2, Biblioteca Basica de Agricultura). Guadalajara, Jalisco, Mexico: Printing Arts.

Rolle, Andrew (1995) General M. G. Vallejo and the Advent of the Americans: A Bibliography. By Alan Rosenus. (Albuquerque: University of New Mexico Press.

Roth, Raymond Papers, University of California Davis Special Collections.

Roos, Bowman, Balch et al. (2014) Pyro geography, historical ecology, and the human dimensions of fire regimes. Journal of Biogeography.

Rothstein, R. (2017) The Color of Law. A Forgotten History of How our Government Segregated America. Liveright Publishing Corporation.

Rothenberg, D. (1998) With These Hands: the Hidden World of Migrant Farmworkers Today. University of California Press.

Sauer, C. O. (1963) Land and Life, A Selection from the Writings of Carl Ortwin Sauer. Edited by John Leighly. University of California Press, Berkeley and Los Angeles.

Sauer, C. O. Papers, University of California Special Collections. Bancroft Library.

Saxton, Alexander (1971) The Indispensable Enemy: Labor and the Anti-Chinese Movement in California.

Schumaker et al (2019) Evolution and Collapse of Ejidos in Mexico—To What Extent Is Communal Land Used for Urban Development? Land 2019, 8(10), 146

Sheridan, R. Fulé, Lee, M. Nielsen, E (2015) Identifying Social-ecological Linkages to Develop a Community Fire Plan in Mexico, Conservation and Society 13(4):395-406, DOI: 10.4103/0972-4923.179884

Sosa, A. (2024) "State may end forced labor" The Press Democrat reprinted from the Los Angeles Times. June 20, 2024.

Soong, J.L., Janssens, I.A., Grau, O. et al. Soil properties explain tree growth and mortality, but not biomass, across phosphorus-depleted tropical forests. Sci Rep 10, 2302 (2020).

Steinbeck, John, 1939, The Grapes of Wrath. Random House.

Stephens Scott, L. , Hall, Les, Stephens, Connor W. Bernal, Alexis A. and Collins, Brandon M. (2023) Degradation and restoration of Indigenous California black oak (Quercus kelloggii) stands in the northern Sierra Nevada Stephens et al. Fire Ecology

Stephens, S. L. and Ruth, W. (2005) Federal forest-fire policy in the United States. Ecological Applications, 15(2), 532-542.

Stewart, O Edited by Anderson K. (2002) Forgotten Fires, Native Americans and the Transient Wilderness. University of Oklahoma Press.

Syphard, A. D., Radeloff, V. C., Keeley, J. E., Hawbaker, T. J., Clayton, M. K., Stewart, S. I. and Hammer, R. B. (2007) Human Influence on California Fire Regimes. Ecological Applications, 17:

Tsu, Cecilia M. (2013) Garden of the World: Asian Immigrants and the Making of Agriculture in California's Santa Clara Valley.

Torres, M. (2001) The Making of the Mexican Border, University of Texas, Press.

University of California Berkeley 'FIRE,' (Fall 2020) Anthropology C12AC/ESPM C22AC Guest Lectures by Ron Goode, Corinna Gould, Valentin Lopez and Rob Cutthrell Cited in text.

Vlamis J, Schultz A, Biswell H. 1955. Burning and soil fertility: Greenhouse tests with lettuce and barley indicate nutrient content of forest soils increased by prescribed burning. Hilgardia 9(3):7-7.

Way, Peter, (1993) Common Labor: Workers and the Digging of North American Canals, 1780-1860.

Westerling, A. (2008) Climate and Wildfire in the Western United States.

Wieger, L. (1965) Chinese Characters: Their origin, etymology, history, classification and signification. Dover Publications. New York.

Saving Places (Accessed 2023) Restoring the historic Japanese gardens of Manzanar, https://savingplaces.org/stories/restoring-the-historic-japanese-gardens-of-manzanar

Additional Notes and Website Resources:

https://www.wilsoncenter.org/article/mexican-braceros-and-us-farm-workers

https://www.camafu.org.mx/reporte-y-acumulado-de-incendios-forestales-enero-2018/

https://www.camafu.org.mx/index.php/manejo-del-fuego-2/

https://www.fs.fed.us/psw/publications/documents/psw_gtr245/es/psw_gtr245_363.pdf

https://www.fs.fed.us/psw/publications/documents/psw_gtr245/es/psw_gtr245_363.pdf

https://ourworld.unu.edu/en/yakihata

https://www.ancient.eu/article/1082/food--agriculture-in-ancient-japan/

https://www.jstage.jst.go.jp/article/tropics/22/4/22_131/_pdf

https://www.pressdemocrat.com/article/specialsections/braceros-helped-save-sonoma-county-crops-during-world-war-ii/?sba=AAS

https://compassjournal.org/the-bracero-program-1942-1964/

http://www.sfmuseum.org/hist9/harvest.html

http://calag.ucanr.edu/Archive/?article=ca.v066n03p85

https://www.kvpr.org/post/despite-tight-restrictions-open-ag-burning-increases-valley

References and Bibliography: Chapter 2 - The Politics of Practice

Ager, A.A., N.M. Vaillant, and M.A. Finney. 2011. Integrating fire behavior models and geospatial analysis for wildland fire risk assessment and fuel management planning. J. Comb. Article ID 572452, 19pp

Ager, A.A, M.A. Finney, A. McMahan, and J. Cathcart. 2010. Measuring the effect of fuel treatments on forest carbon using landscape risk analysis. Nat. Hazards Earth Systems Science 10:2525-2562

Ager, A.A., N. Vaillant, and M.A. Finney. 2010. A comparison of landscape fuel treatment strategies to mitigate wildland fire risk in the urban interface and preserve old forest structure. Forest Ecol. Mgt. 259(8): 1556-1570

Agrawal, A. & E. Ostrom. 2008. "Decentralization and Community-Based Forestry: Learning from Experience." In Decentralization, Forests and Rural Communities: Policy Outcomes in South and Southeast Asia. E.L. Webb & G.P. Shivakoti, eds. Los Angeles, CA: SAGE Publications.

Agnew, J. (1994). The Territorial Trap: The Geographical Assumptions of International Relations Theory. Review of International Political Economy, 1(1), 53–80.

Agnew, J.A. (2013) Arguing with Regions, Regional Studies, 47:1, 6-17

Air Resources Board (2013) Biomass Conversion Information Paper, California.

Andersson, K.P. & E. Ostrom. 2008. "Analyzing Decentralized Resource Regimes from a Polycentric Perspective." Policy Sciences 41(1):71-93.

Anderson, M. K. (2005) Tending the Wild: Native American Knowledge and the Management of California's Natural Resources Journal of California and Great Basin Anthropology.

Alexander, Rani T. (2019) Technology and Tradition in Mesoamerica after the Spanish Invasion – Archaeological Perspectives, University of New Mexico Press, Albuquerque.

Arizona Daily Sun (2015) Flagstaff compost business joins forest restoration. Emery Cowan, Jan 16, 2015

Armitage, D., F. Berkes, and N. Doubleday (eds.). 2007. Adaptive co-management: Collaboration, learning and multilevel governance. Vancouver: UBC Press.

Bale, Catherine S.E., Varga, L. Foxon, Timothy J. (2015) Energy and complexity: New ways forward, Applied Energy, Volume 138, 2015, Pages 150-159, ISSN 0306-2619

Barros, A. et al. (2017) Spatiotemporal dynamics of simulated wildfire, forest management, and forest succession in central Oregon, USA

Bennett, N. J. et al. Conservation social science: understanding and integrating human dimensions to improve conservation. Biological Conservation 205, 93–108 (2017).

Berck, Peter (1999) Why are the Uses Multiple? Multiple Use of Forests and Other Natural Resources, Volume 61 of the series Forestry Sciences pp 3-13

Berkes, F., and C. Folke. (1998) Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge University Press, New York, New York, USA.

Berkes, F., J. Colding, and C. Folke. (2000) Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications. 10(5):1251-1262.

Berkes, F. (2007) Community-based conservation in a globalized world. Proceedings of the National Academy of Sciences 104(39):15188-15193.

Berkes, F. (2008) Sacred ecology: traditional ecological knowledge and resource management. 2nd edition. Taylor & Francis, Philadelphia, USA.

Berkes, F. 2009. Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. Journal of Environmental Management 90: 1692–1702.

Berry , W. (1987). Home Economics: Fourteen Essays. San Francisco, CA: North Point Press.

Best, D. (2014) "Bioenergy: Opportunities for Mitigation, Negative Emissions" Keynote presentation at International Conference on Biomass Tech/World Bioenergy Symposium, Changsha, P.R. China

Best, D. V. (2019) Wildfire, Forest and Energy System Resilience: Critical Drivers and Values at Risk to Electricity Reliability and Ecological Security, Presentation at INRA Seminar - Toulouse, France

Best, D.V. et al. (2018) Assessing a Greenhouse Gas Baseline for the County of Laikipia, Kenya, Poster presented at the 7th International Symposium on Energy from Biomass and Waste, October 2018, Venice, Italy.

Best, D.V and Kammen, D. (2018) California Energy System / San Joaquin Valley considering the SWITCH modeling platform. Presentation at IEA-EPRI Energy & Capacity Trading Workshop, August 2018.

Best, D. (2017) “The New Clean Energy Nexus? Electricity and Ecological Resilience” Keynote Presentation at ICCE Xian, China 15th International Conference on Clean Energy (ICCE), Xian Jiaotong University and State Key Lab.

Best, D. (Master of Science Thesis 2017) The Values of Anthropogenic Disturbance: Evaluating the human impacts of wildfire risk: land-use decision-making with geospatial applications in Mediterranean zones. University of California, Berkeley.

Best, D.V. and Giardine, F. (2020) Sustainable Energy and Localized Futures an INDI-GIS Approach. California Energy Commission EPIC Funded Project Website. Accessed on 11/06/2020
https://sites.google.com/berkeley.edu/self-indi-gis/self-indi-gis-project-overview

Bettinger, P. (2015) Integrating Forestry in Land Use Planning, Current Forestry Rep.

Biswell, H. (1999) Prescribed Burning in California Wildlands Vegetation Management. University of California Press

Bormann, B.T., and A.R. Kiester. 2004. Options forestry: Acting on uncertainty. Journal of Forestry 102: 22–27.

Bowman D, Balch J, Artaxo P, Bond WJ, Cochrane MA, D’Antonio C.M. (2011) The human dimension of fire regimes on Earth. J Biogeography. 2011; 38: 2223–2236. PMID: 22279247

Brandt, C.S. (1966) Agricultural Burning, Journal of the Air Pollution Control Association, 16:2, 85-86, DOI: 10.1080/00022470.1966.10468447

Chung, W. et al. (2013) Optimising fuel treatments over time and space. International Journal of Wildland Fire

Chung W. (2015) Optimizing Fuel Treatments to Reduce Wildland Fire Risk. Springer International Publishing

Cochrane, M.A., C.J. Moran, M.C. Wimberly, A.D. Baer, M.A. Finney, K.L. Beckendorf, J. Eidenshink, Z. Zhu. 2012. Estimation of wildfire size and risk changes due to fuels treatments. Intl. J. Wildl. Fire. 21(4): 357-367

Cooney, R. & Dickson, B., 2012. Biodiversity and the Precautionary Principle: Risk, Uncertainty and Practice in Conservation and Sustainable Use, Taylor & Francis.
Coop et al. (2020) Wildfire Driven Forest Conversion in Western North American Landscapes

Couture, S. and Reynaud, A. (2011) Forest management under fire risk when forest carbon sequestration has value. Ecological Economics, 2011

Cullenward, D. and Victor, D (2021) Making Climate Policy Work. Stanford Press.

Curt, Thomas and Frejaville, T (2018) Wildfire Policy in Mediterranean France: How Far is it Efficient and Sustainable? Risk Analysis, Vol. 38, No. 3, 2018

Darques, Regis (2015) Mediterranean cities under fire. A critical approach to the wildland-urban interface. Applied Geography.

Earles, J.M. North, M. AND Hurteau, M. (2014) Wildfire and drought dynamics destabilize carbon stores of fire-suppressed forests Ecological Applications.

Ehrlich, Paul R. (1975). The Population Bomb. Rivercity, Mass.: Rivercity Press

El-Owaidy, H. , Al-Thumairi, A. (2009) On perturbation of the Lotka–Volterra model. Applied Mathematics Letters, Volume 22, Issue 4, April 2009, Pages 557-560

Espindola et al (2017) Social Factors of Land Use and Vegetation Related to Forest Fires in Hidalgo State. Revista Mexicana De Sciencias Forestales.

Finney, M.A. (2004) Landscape fire simulation and fuel treatment optimization. In Methods for integrated modeling of landscape change: Interior Northwest landscape analysis system. Edited J.L. Hayes, A.A. Ager, and J.R. Barbour. USDA For. Serv. Gen. Tech. Rep. PNW-GTR- 610. pp. 117–131

Finney (2006) An Overview of FlamMap Fire Modeling Capabilities USDA Forest Service Proceedings

Finney MA. (2007) A computational method for optimizing fuel treatment locations. Int. J. Wildland Fire 16(6): 702-711

Finney MA, Seli RC, McHugh CW, Ager AA, Bahro B, Agee JK. (2007) Simulation of long-term landscape-level fuel treatment effects on large wildfires. Int. J. Wildland Fire 16(6): 712-727

Finney, M.A., C.W. McHugh, I.C. Grenfell, K.L. Riley, K.C. Short. 2011. A simulation of probabilistic wildfire risk components for the Continental United States. Stochastic environmental research and risk assessment. 25(7): 973-1000.

Fisher, C., Pollard, H. and Frederick, C. (1999) Intensive agriculture and socio-political development in the Lake Patzcuaro Basin, Michoacan, Mexico. Antiquity, 73, 281; ProQuest pg. 642

Foster, J. B. (1997) The Crisis of the Earth: Marx's Theory of Ecological Sustainability as a Nature-Imposed Necessity for Human Production. Organization & Environment, 10(3), 278–295. http://www.jstor.org/stable/26161524

Forest Research (2014) Using quality compost to reclaim land for forestry and woody biomass. Technical Development, Report reference FCJR104, March 2014 Job: TD 26/11

Fulé, P.Z. y Covington (1999) Fire regime changes in La Michilia Biosphere Reserve, Durango Mexico, Conservation Biology, 13(3) 640-652

Fulé, P.Z, Ramos Gomez, M, Cortes-Montano, C and Miller A. M. (2011) Fire regime in Mexican forest under indigenous resource management. Ecological Applications, 21(3) 764-775.

Fulé, P. (2015). Practical advice for reforestation at large scales around the globe. Journal of Forestry, 113(4), 435-436. DOI: 10.5849/jof.15-995

Gonzales et al. (2013) Cost analysis for high-volume and long-haul transportation of densified biomass. Transportation Research Part A 49 (2013) 48–61

González Rosales, A. y Rodríguez Trejo, D.A. 2004. Efecto del chamuscado de copa en el crecimiento en diámetro de Pinus hartwegii. Agrociencia 38(5): 537-544.

Graeber, D., & Wengrow, D. (2023). The dawn of everything: a new history of humanity. First paperback edition. New York, Picador.

Grove, Wayne A. (1996) The Mexican Farm Labor Program, 1942-1964: Government-Administered Labor Market Insurance for Farmers. Agricultural History, Vol. 70, No. 2, Twentieth-Century Farm Policies (Spring, 1996), pp. 302-320 (19 pages)

Gunderson and Hollings, C.S. Panarchy (2002) Panarchy: understanding transformations in human and natural systems. Edited with L. Gunderson, (editors) Washington, DC: Island Press.

Hakkila, P. (2012) Utilization of Residual Forest Biomass, Springer Science & Business Media, Dec 6, 2012 - Technology & Engineering - 568 pages

Hart, E. ichard, Across Boundaries: Transborder Interaction in Comparative Perspective, Western Historical Quarterly, Volume 19, Issue 1, January 1988, Page 89

Harvey D. (2014) Seventeen Contradictions and the End of Capitalism, Oxford University Press

Helms, J.A. (1979) Positive effects of prescribed burning on wildfire intensities. Fire Management Notes. 40(3): 10-13.

Hobbs, R. J. et al. Novel ecosystems: theoretical and management aspects of the new ecological world order. Glob. Ecological Biogeography. 15, 1–7 (2006).

Holland, John (2014) Signals and Boundaries, MIT Press

Howitt, R. & Lunkapis, Gaim. (2010), Coexistence: Planning and the challenge of indigenous rights.

International Energy Agency (IEA), Bioenergy (2016) Cascading of woody biomass: definitions, policies and effects on international trade.

International Institute for Applied Systems Analysis (IIASA)Website Description of Geographic Orientation https://www.iiasa.ac.at/web/home/about/whatisiiasa/history/founding/the_founding_of_the_institute.html

International Institute for Applied Systems Analysis (IIASA) Globium Model Website

International Institute for Applied Systems Analysis (IIASA) BeWhere Model Website

Isard, W. (1966). Methods of regional analysis. Рипол Классик.

Janssen, M. and Ostrom, E. (2006) Governing Social-Ecological Systems. Chapter 30 in Handbook of Computational Economics, 2006, vol. 2, pp 1465-1509 from Elsevier

Jacoby E. H in collaboration with Jacoby C.F. (1971) Man and Land: The Fundamental Issue in Development. Knopf, Deutsch.

Jaiarree et al (2014) Carbon Budget and Sequestration Potential in a Sandy Soil Treated with Composts. Land Degradation & Development. 25: 120–129

Jasonoff, S. A (2010) New Climate for Society. Theory, Culture & Society 2010 (SAGE, Los Angeles, London, New Delhi, and Singapore), Vol. 27(2–3): 233–253

Jeffrey, Richard C. (1983) The Logic of Decision. University of Chicago Press, Chicago, Il, second edition.

Johnson, L. (2015) Catastrophic fixes: cyclical devaluation and accumulation through climate change impacts Environment and Planning A 2015, volume 47, pages 2503–2521

Justus J. (2008) Ecological and Lyapunov Stability, Philosophy of Science.

Kabli, M. et al. (2015) A Stochastic Programming Model for Fuel Treatment Management, Forests

Kalabokidis, K., P. Palaiologou, N. Athanasis, C. Vasilakos, M.A. Finney, A. Ager. 2014. Minimum travel time algorithm for fire behavior and burn probability in a parallel *computing environment. 7th Intl. Conf. Forest Fire Research, Advances in Fire Research, D.X. Viegas (ed.), pp. 882-891*

Keeney, R. L. and Raiffa, H. (1976, 1993) Decisions with multiple objectives: Preferences and value tradeoffs. Cambridge University Press, Cambridge, UK, 1993.

Kennedy, M.C, E.D. Ford, P. Singleton, M. Finney, and J.K. Agee. 2008. Informed multi-objective decision-making in environmental management using Pareto optimality. Journal of Appl. Ecology 45:181-192

Khorram, M.S. (2016) Biochar: A review of its impact on pesticide behavior in soil environments and it's potential applications, Journal of Environmental Sciences · March 2016

Kim, Y.H., P. Bettinger, M. Finney. 2008. Spatial optimization of the pattern of fuel management activities and subsequent effects on simulated wildfires. European Journal of Operational Research. 197:253-265

Knight, R.L and Landres, P. (1998) Stewardship Across Boundaries. Island Press

Kellert, S. H. (1993). In the wake of chaos: Unpredictable order in dynamical systems. University of Chicago press.

Konoshima, M. Albers, H. Montgomery, C. and Arthur, J. (2010) Optimal spatial patterns of fuel management and timber harvest with fire risk, Canadian Journal for Forestry Research

Kraxner F., Fuss S., Krey V., Best D., Leduc S., Kindermann G., Yamagata Y., Schepaschenko D., Shvidenko A., Aoki K., Yan J. (2015) The role of bioenergy with carbon capture and storage (BECCS) for climate policy. V. 3. P. 1466-1483. In: Yan J (Ed), The Handbook of Clean Energy Systems. John Wiley & Sons, Ltd.

Lake F. K. Parrotta, J. Giardina, C. P. Davidson Hunt, I. Uprety, Y. (2017) Integration of TEC and WEST

Laitila, J. et al (2016) Cost analysis of transporting forest chips and forest industry by-products with large truck-trailers in Finland, Biomass and Bioenergy 90 (July 2016):252–261 · May 2016

Larsen (1995) Forest Ecology and Management. Ecological stability of forests and sustainable Silviculture.

Lohmann, Larry (2010) 'Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes', New Political Economy, 15: 2, 225 — 254

Lowe, J. (2021). Breathing fire: female inmate firefighters on the front lines of California's wildfires. First edition. New York, MCD / Farrar, Straus and Giroux.

Li, An. et al. (2011) Modeling human decisions in coupled human and natural systems: Review of agent-based models. Ecological Modeling.

Little Hoover Commission (2018) Fire on the Mountain: Rethinking Forest Management in the Sierra Nevada, Forest Management, Report #242, February 2018

Liu Z.Yang J. He, HS. (2013) Studying the effects of fuel treatment based on burn probability on a boreal forest landscape. Journal of Environmental Management.

Millar, C. I., Stephenson, N. L. and Stephens, S. L. (2007), Climate Change and Forests of the Future: Managing Under Uncertainty. Ecological Applications, 17: 2145–2151. doi:10.1890/06-1715.1

Moghaddas et al. (2010) Fuel Treatment effects on modeled landscape-level fire behavior in the northern Sierra Nevada.

Moritz, M.et al. (2014) Learning to coexist with wildfire. Nature

The Nature Conservancy (2019) Notes from a discussion with Post Doc Fellow at American Geophysical Union Annual Meeting, San Francisco December.

Odum, H. (2000) Modeling for all Scales: An introduction to System Simulation, Academic Press. (1962)

Odenbaugh (2000) Ecological Stability, Model Building, and Environmental Policy: A Reply to Some of the PessimismPhilosophy of Science, Vol. 68, No. 3, Supplement: Proceedings of the 2000 BiennialMeeting of the Philosophy of Science

Oi, W. and Hurter, A. (1967) The Economics of Private Truck Transport

Oliver A. and Khanna M. (2017) Demand for biomass to meet renewable energy targets in the United States: implications for land use. Global Change Biology Bioenergy

Ostrom, Elinor (1990) Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, UK. Chapter 3. Analyzing long enduring self-organized collective CDRs

Ostrom, Elinor (2005) Understanding Institutional Diversity. Princeton University Press, Princeton, NJ.

Ostrom, E. Burger, J. Field, C, Norgaard, R, Policansky, D. (1999) Revisiting the Commons: Local lessons, global challenges. Vol 284, Science.

Patton-Mallory, Marcia, ed. 2008. Forest Service, U.S. Department of Agriculture woody biomass utilization strategy. Washington, DC: U.S. Department of Agriculture, Forest Service. 17 p.

Polanyi, K. (1944, 1957, 2001) The Great Transformation. Beacon Press, Boston Mass. The Self Regulating Market and the Fictitious Commodities - Labor, Land and Money.

Pyne, Stephen (2015) Between Two Fires: A Fire History of Contemporary America, Tucson: University of Arizona Press.

Pyne, Stephen (2016) California: A Fire Survey (2016), Tucson: University of Arizona Press, 2016.

QGIS.org (1997-2024). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.org

Lawrence, Quil (2023)"The military is turning to microgrids to fight global threats — and global warming" National Public Radio. October 2, 2023

Rodriguez-Trejo, D. et al. (2011) The Present Status of fire ecology, traditional use of fire, and fire management in Mexico and Central America. Fire Ecology, 7(1) 40-56.

Rodriguez-Trejo, D.A. (2015). Incendios de Vegetacion, su ecologia, manejo e historia (Vol. 2, Biblioteca Basica de Agricultura). Guadalajara, Jalisco, Mexico: Printing Arts.

Roos, Bowman, Balch et al. (2014) Pyro geography, historical ecology, and the human dimensions of fire regimes. Journal of Biogeography.

Rosen and Painter (2019) From Citizen Control to Co-Production: Moving Beyond a Linear Conception of Citizen Participation, Journal of American Planning Association

Sauer, C. O. (1963) Land and Life, A Selection from the Writings of Carl Ortwin Sauer. Edited by John Leighly. University of California Press, Berkeley and Los Angeles.

Schelling, Thomas (1985) Choice and Consequence. Harvard University, Cambridge, MA.

Schumaker et al (2019) Evolution and Collapse of Ejidos in Mexico—To What Extent Is Communal Land Used for Urban Development? Land 2019, 8(10), 146

Schulz, J. et al. (2017) Expansion of short rotation forestry: characterization of determinants with an agent-based land use model. GCB Bioenergy (2017) 9, 1042–1056, doi: 10.1111/gcbb.12400

Schulman, P. , Roe, E. van Eeten, M. , Mark De Bruijne, M. (2004) High Reliability and the Management of Critical Infrastructures, Journal of Contingencies and Crisis Management, 12(1): 14-28

Searcy, Erin et al. (2007) The Relative Cost of Biomass Energy Transport, 137-140, Applied biochemistry and biotechnology, 10.1007/s12010-007-9085-8

Seidl, R. (2014) The Shape of Ecosystem Management to Come: Anticipating Risks and Fostering Resilience 2014, BioScience Vol. 64 No. 12

Sen, Amartya (1977) Rational fools: A Critique of the behavioral foundations of economic theory. Philosophy and Public Affairs.

Sheridana, Ras (2015) Identifying Social-ecological Linkages to Develop a Community Fire Plan in Mexico, Conservation and Society 13(4):395-406, DOI: 10.4103/0972-4923.179884
Sherman, L. et al (2017) Idaho forest growth response to post‐thinning energy biomass removal and complementary soil amendments

Siderius, T., and Zink, T. (2022) 'Markets and the future of the Circular Economy'. Circular Economy and Sustainability,

Simon, Herbert (1982), "The Architecture of Complexity," pp. 193-230 in The Sciences of the Artificial, Second Edition, The MIT Press, Cambridge, MA.

Smil, Vaclav. (2017) Energy and Civilization: A History. Cambridge, Massachusetts, The MIT Press.

Spies, T. A., et al. (2017) Using an agent-based model to examine forest management outcomes in a fire-prone landscape in Oregon, USA. Ecology and Society 22(1):25.

Stephens, Scott L., Hall, Les, Stephens, Connor W. Bernal, Alexis A. and Collins, Brandon M. (2023) Degradation and restoration of Indigenous California black oak (Quercus kelloggii) stands in the northern Sierra Nevada Stephens et al. Fire Ecology (2023) 19:12

Stephens, S. L. and Ruth, W. (2005) Federal forest-fire policy in the United States. Ecological Applications, 15(2), 532-542.

Stephens, SL and Ruth, LW. (2005) Federal Forest Policy in the Unoted States, Ecological Applications

Stephens et al. (2010) Operational approaches to managing forests of the future in Mediterranean regions within a context of changing climates. Environmental Research Letters

Stephens, S.L., B.M. Collins, E. Biber, and P.Z. Fule'. (2016) U.S. federal fire and forest policy: emphasizing resilience in dry forests. Ecosphere 7(11): e01584.10.1002/ecs2.1584

Stern, P.C. (2011) Design principles for global commons: natural resources and emerging technologies. International Journal of the Commons.

Stewart, O Edited by Anderson K. (2002) Forgotten Fires, Native Americans and the Transient Wilderness. University of Oklahoma Press.

Swedlow, B. Kall, D. Zhou, Zheng. Hammitt, J. Wiener, J. (2009) Research Methods and Approaches: Theorizing and Generalizing about Risk Assessment and Regulation through Comparative Nested Analysis of Representative Cases , Law and Policy.

Syphard, A. D., Radeloff, V. C., Keeley, J. E., Hawbaker, T. J., Clayton, M. K., Stewart, S. I. and Hammer, R. B. (2007), Human influence on California wildfire regimes. Ecological Applications, 17: 1388–1402. doi:10.1890/06-1128.

Tavoni, M., Sohngen, B. Bosetti, V. (2007) Forestry and the carbon market response to stabilize climate. Fondazione Eni Enrico Mattei.

Taylor M. et al. (2015) The Economics of Ecological Restoration and Hazardous Fuel Reduction Treatments in the Ponderosa Pine Forest Ecosystem. Forest Science, Volume 61, Issue 6, 23 December 2015, Pages 988–1008, https://doi.org/10.5849/forsci.

Thomas, D. et al (2017) Revisiting Wildland Fire Fuel Quantification Methods: The Challenge of Understanding a Dynamic, Biotic Entity

Thompson J. et al. (2012) Trucking Characteristics for an In-woods Biomass Chipping Operation. USDA Forest Service 35th Council on Forest Engineering Annual Meeting. 2012. New Bern, North Carolina

Timmons, D. et al (2017) The Economics of Biochar Carbon Sequestration in Massachusetts, University of Massachusetts

Thompson, M.P, D.E. Calkin and M.A. Finney, K.M. Gebert, and M.S. Hand. 2013. A risk-based premium approach to wildland fire finance and planning. Journal: Forest Science. 59(1):63-77.

Tsebelis, G. (1992) Nested Games. Rational Choice in Comparative Politics, Berkeley, Los Angeles, Oxford, California University Press.

Tomasello M. (2009) Why We Cooperate. MIT Press, Cambridge, M.A.

Tversky, A. and Kahneman D. (1981) The Framing of Decision and the Psychology of Choice, Science.

Walker, R. (2001) California's Golden Road to Riches: Natural Resources and Regional Capitalism, 1848–1940, Annals of Association of American Geographers

Wei H. et a. (2012) Biotechnol Biofuels. 2012 Tracking dynamics of plant biomass composting by changes in substrate structure, microbial community, and enzyme activity

Weise, D. et al (2003) Comparing potential fuel treatment trade-off models. In: Arthaud, Greg J.; Barrett, Tara M., eds. 2003. Systems Analysis in Forest Resources: Proceedings of the 8th Symposium

Westerling, A. (2008) Climate and Wildfire in the Western United States. UC Merced Press

Wilson, Edward O., author. (1978). On human nature. Cambridge: Harvard University Press.

Wilson, E.O. (2000) Sociobiology: The New Synthesis, Twenty-fifth Anniversary Edition. Belknap Press of Harvard University Press, M.A.

Wulf, A., & Drummond, D. (. (2015). The invention of nature: Alexander Von Humboldt's new world. ; Chicago / Turabian

Vandakasteele, B. (2016) Combining woody biomass for combustion with green waste composting: Effect of removal of woody biomass on compost quality Waste Management, Volume 58, December 2016, Pages 169-180

Vlamis J, Schultz A, Biswell H. 1955. Burning and soil fertility: Greenhouse tests with lettuce and barley indicate nutrient content of forest soils increased by prescribed burning. Hilgardia 9(3):7-7.

Xiao E. and Kunreuther H. (2010) Punishment and cooperation in stochastic social dilemmas, Working Paper Wharton School, University Pennsylvania

Yu, W. (2012) Optimize landscape fuel treatment locations to create control opportunities for future fires. Canadian Journal of Forest Research, 2012, Vol. 42, No. 6 : pp. 1002-1014

Zuber, S (2010) The aggregation of preferences: can we ignore the past? Theory and Decision, volume 70, p. 367 – 38

Chapter two websites:

California Energy Commission Funded Sustainable Energy and Localized Future Website
https://sites.google.com/berkeley.edu/self-indi-gis/self-indi-gis-project-overview

A history of the International Institute for Applied Systems Analysis
https://www.iiasa.ac.at/web/home/about/whatisiiasa/history/founding/the_founding_of_the_institute.html

References and Bibliography: Chapter 3 - Manzanita Rising

Abrahamson, I. (2014) Arctostaphylos manzanita. Fire Effects Information System. https://www.fs.fed.us/database/feis/plants/ shrub/arcman/all.html; U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, 2014

Agee, James K.; Biswell, Harold H. 1978. The fire management plan for Pinnacles National Monument. In: Linn, Robert M., ed. Proceedings, 1st conference on scientific research in the National Parks: Vol. 2; 1976 November 9-12; New Orleans, LA. NPS Transactions and Proceedings No. 5. Washington, DC: U.S. Department of the Interior, National Park Service: 1231-1238.

Amme, David, "An Introduction to California's Native Grasses," Manzanita (Berkeley: Regional Park Botanic Garden, Tilden Park), Vol. 1, No. 2, Fall 1997.

Anderson, Kat M. and Rosenthal, Jeffrey (2015) "An Ethnobiological Approach to Reconstructing Indigenous Fire Regimes in the Foothill Chaparral of the Western Sierra Nevada," Journal of Ethnobiology.

Anderson, M. K. (2005) Tending the Wild: Native American Knowledge and the Management of California's Natural Resources Journal of California and Great Basin Anthropology.

Arno, Stephen F. 2000. The 100-year crusade against fire: its effect on western forest landscapes. In: Pioneering new trails: Proceedings of the Society of American Foresters 1999 national convention;1999 September 11-15; Portland, OR. SAF Publication 00-1. Bethesda, MD.

Arno, Stephen F.; Wilson, Andrew E. 1986. Dating past fires in curlleaf mountain-mahogany communities. Journal of Range Management.

Arno, Stephen F.; Scott, Joe H.; Hartwell, Michael G. 1995. Age-class structure of old growth ponderosa pine/Douglas-fir stands and its relationship to fire history. Res. Pap. INT-RP-481. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Baisan, Christopher H.; Swetnam, Thomas W. 1990. Fire history on a desert mountain range: Rincon Mountain Wilderness, Arizona, U.S.A. Canadian Journal of Forest Research.

Barbour, Michael G. 1988. Californian upland forests and woodlands. In: Barbour, Michael G.; Billings, William Dwight, eds. North American terrestrial vegetation. Cambridge; New York: Cambridge University Press

Bean, J.L. and Saubel, K. S. (1972.) Telmalpakh: Chauilla Indian knowledge and usage of plants. Banning, CA: Malki Museum.

Bennett, Duane A. 1995. Fuelwood harvesting in the sky islands of southeastern Arizona. In: DeBano, Leonard F.; Ffolliott, Peter F.; Ortega-Rubio, Alfredo; [and others], technical coordinators. Biodiversity and management of the Madrean Archipelago: the sky islands of southwestern United States and northwestern Mexico: Proceedings; 1994 September 19-23; Tucson, AZ. Gen. Tech. Rep. RM-GRT-264. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 519-523. [26252]

Best (2023) Ode to Manzanitas: To Tree or not to Tree. Presentation at Fire Ecology Lab, University of California Berkeley, Feb. 21, 2023. Mulford Hall.

Biswell, H. H.; Schultz, A. M. 1958. Manzanita control in ponderosa. California Agriculture. 12(2)

Blackburn, Thomas C., and Anderson, Kat, eds, Before the Wilderness, Environmental Management by Native Californians. (Menlo Park: Ballena Press), 1993.

Brennan et al (1987) Habitat Use By Mountain Quail In Northern California, The Cooper Ornithological Society 1987

Brown, David E. 1982. Madrean evergreen woodland. In: Brown, David E., ed. Biotic communities of the American Southwest--United States and Mexico. Desert Plants. 4(1-4): 59-65.

Cable, Dwight R. 1975. Range management in the chaparral type and its ecological basis: the status of our knowledge. Res. Pap. RM-155. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 30 p.

Caprio, Anthony C.; Zwolinski, Malcolm J. 1995. Fire and vegetation in a Madrean oak woodland, Santa Catalina Mountains, southeastern Arizona.

Caprio, Anthony Conger. 1994. Fire effects and vegetation response in a Madrean oak woodland, southeastern Arizona. Tucson, AZ: The University of Arizona, School of Renewable Natural Resources. 297 p. Thesis.

Carmichael, R. S.; Knipe, O. D.; Pase, C. P.; Brady, W. W. 1978. Arizona chaparral: plant associations and ecology. Res. Pap. RM-202. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 16 p.

Conrad, C. Eugene. 1987. Common shrubs of chaparral and associated ecosystems of southern California. Gen. Tech. Rep. PSW-99. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 86 p.

Cooper, Charles F. 1961. Pattern in ponderosa pine forests. Ecology. 42(3): 493-499.

Coty N. Jen, Yutong Liang, Lindsay E. Hatch, Nathan M. Kreisberg, Christos Stamatis, Kasper Kristensen, John J. Battles, Scott L. Stephens, Robert A. York, Kelley C. Barsanti, Allen H. Goldstein (2018) High Hydroquinone Emissions from Burning Manzanita Environ. Sci. Technol. Lett. 2018, 5, 6, 309–314*

Darrow, Robert A. 1944. Arizona range resources and their utilization: 1. Cochise County. Tech. Bull. 103. Tucson, AZ: University of Arizona, Agricultural Experiment Station: 311-364. [4521]

DeVelice, Robert L.; Ludwig, John A. 1983. Forest habitat types south of the Mogollon Rim, Arizona and New Mexico. Final report: Cooperative Agreement No. 28-K2-240. Las Cruces, NM: New Mexico State University.

Dunn, Anthony T. 1987. Population dynamics of the Tecate cypress. In: Elias, Thomas S., ed. Conservation and management of rare and endangered plants: Proceedings of a California conference on the conservation and management of rare and endangered plants; 1986; Sacramento, CA. Sacramento, CA: California Native Plant Society: 367-376.

Eddy, Thomas A. 1961. Foods and feeding patterns of the collared peccary in southern Arizona. Journal of Wildlife Management. 25: 248-257.

Eloy, Christophe. “Leonardo’s Rule, Self-Similarity, and Wind-Induced Stresses in Trees.” Physical Review Letters, vol. 107, no. 25, Dec. 2011

Epling, Carl; Lewis, Harlan. 1942. The centers of distribution of the chaparral and coastal sage associations. The American Midland Naturalist. 27: 445-462.

Estrada-Castillon, Educardo; Jurado, Enrique; Navar, Jose J.; Jimenez-Perez, Javier; Garza-Ocanas, Fortunato. 2003. Plant associations of Cumbres de Majalca National Park, Chihuahua, Mexico. The Southwestern Naturalist. 48(2): 177-187.

Fried, Jeremy S.; Bolsinger, Charles L.; Beardsley, Debby. 2004. Chaparral in southern and central coastal California in the mid-1990s: area, ownership, condition, and change. Resource Bulletin PNW-RB-240. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 86 p.

Fule, Peter Z.; Covington, W. Wallace. 1999. Fire regime changes in La Michilia Biosphere Reserve, Durango, Mexico. Conservation Biology. 13(3): 640-652.

Fule, Peter Z.; Garcia-Arevalo, Abel; Covington, W. Wallace. 2000. Effects of an intense wildfire in a Mexican oak-pine forest. Forest Science. 46(1): 52-61.

Fule, Peter Z.; Garcia-Arevalo, Abel; Covington, W. Wallace (2000) Effects of an intense wildfire in a Mexican oak-pine forest. Forest Science. 46(1): 52-61.

Fulton, Robert E.; Carpenter, F. Lynn. 1979. Pollination, reproduction, and fire in California Arctostaphylos. Oecologia. 38: 147-157.

Fried, Jeremy S.; Bolsinger, Charles L.; Beardsley, Debby. (2004) Chaparral in southern and central coastal California in the mid-1990s: area, ownership, condition, and change. Resource Bulletin PNW-RB-240. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 86 p.

Gibson, James (1979) The Ecological Approach to Visual Perception. Psychology Press Classic Editions, 1979.

Gifford, E. W. 1932 The Southeastern Yavapai. University of California Publications in American Archaeology and Ethnology 29:177-252 (p. 213)

Green, Lisle R. 1981. Burning by prescription in chaparral. Gen. Tech. Rep. PSW-51. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 36 p.

Greenlee, Jason M.; Langenheim, Jean H. 1990. Historic fire regimes and their relation to vegetation patterns in the Monterey Bay area of California. The American Midland Naturalist. 124(2): 239-253.

Hanes, Ted L. (1971) Succession after fire in the chaparral of southern California. Ecological Monographs. 41(1): 27-52.

Heizer, Robert E. & Albert B. Elasasser, The Natural World of the California Indians (Berkeley: Univ. of California Press), 1980.

Hickman, James C., ed. (1993) The Jepson manual: Higher plants of California. Berkeley, CA: University of California Press. 1400 p.

Hobbs. Jerry R. (1995) Sketch of an ontology underlying the way we talk about the world. Int. J. Hum. Comput. Stud., 43(5-6):819–830, 1995.

Holland, Robert F. 1986. Preliminary descriptions of the terrestrial natural communities of California. Sacramento, CA: California Department of Fish and Game. 156 p.

Horn H (2000) Twigs, trees, and the dynamics of carbon in the landscape. In: Brown JH, West GB, editors. Scaling in biology. pp. 199–220.

Jepson Manual, The (1993) Arctostophylos Pungens.

Kahneman, Daniel, (2011) Thinking, fast and slow. Farrar, Straus and Giroux, New York, 2011. multi-object manipulation tasks.

Kauffman, M. Parker, T. and Vasey, M. Photographed by Bisbee, J. (2015) Field Guide to Manzanitas, Back Country Press in Association with California Native Plant Society, North Coast Chapter.

Kearney, Thomas H., Peebles, Robert H., (1960) Arizona Flora. University of California Press, Berkley and Los Angeles, California.

*Keeley et al., Leif L. Richardson*1 and Judith L. Bronstein (2012) Reproductive Biology of Pointleaf Manzanita (Arctostaphylos Pungens) and the pollinator-nectar Robber spectrum. Journal of Pollination Ecology.*

Keeley, J. E. 1976. Morphological evidence of hybridization between Arctostaphylos glauca and Arctostaphylos pungens. Madrono. 23(8): 427-434.

Kummerow, Jochen; Krause, David; Jow, William. 1977. Root systems of chaparral shrubs. Oecologia. 29: 163-177.

Kummerow, Jocken; Borth, Wayne. 1986. Mycorrhizal associations in chaparral. Fremontia. 14(3): 11-13.

Lathrop, Earl W.; Martin, Bradford D. (1982) Response of understory vegetation to prescribed burning in yellow pine forests of Cuyamaca Rancho State Park, California. Aliso. 10(2): 329-343.

Lindenmuth, A. W., Jr.; Glendening, G. E. (1962) Controlled burning of Arizona chaparral: A 1962 progress report. Proceedings, Annual Arizona Watershed Symposium. 6: 23-24.

Marshall, Joe T., Jr. (1957) Birds of pine-oak woodland in southern Arizona and adjacent New Mexico. Pacific Coast Avifauna No. 32. Berkeley, CA: Cooper Ornithological Society. 125 p.

Markwith, Scott H. (2021) Beyond pre-Columbian burning: the impact of firewood collection on forest fuel loads, Canadian Journal of Forest Research, 10 November 2021

Mattana, Efisio, Carta, Angelino, Fernández-Pascual, Eduardo, Keeley, Jon E. Pritchard, Hugh W. (2012) Climate change and plant regeneration from seeds in Mediterranean regions of the Northern Hemisphere; Plant Regeneration from Seeds, 2022

Marshall, Joe T., Jr. 1957. Birds of pine-oak woodland in southern Arizona and adjacent New Mexico. Pacific Coast Avifauna No. 32. Berkeley, CA: Cooper Ornithological Society. 125 p.

Martin, Bradford D. 1982. Vegetation responses to prescribed burning in Cuyamaca Rancho State Park, California. In: Conrad, C. Eugene; Oechel, Walter C., technical coordinators. Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems.

McClaran, Mitchel P.; Brady, Ward W. 1994. Arizona's diverse vegetation and contributions to plant ecology. Rangelands. 16(5): 208-217.

McMahon T (1973) Size and shape in biology. Science (New York, N.Y.) 179: 1201–1204.

McMahon T, Kronauer R (1976) Tree Structures - Deducing principle of mechanical design. Journal of Theoretical Biology 59: 443–466.

Minckley, W. L.; Clark, Thomas O. 1981. Vegetation of the Gila River Resource Area, eastern Arizona. Desert Plants. 3(3): 124-140.

Minnich, R. A.; Barbour, M. G.; Burk, J. H.; Sosa-Ramirez, J. 2000. California mixed-conifer forests under unmanaged fire regimes in the Sierra San Pedro Martir, Baja California, Mexico. Journal of Biogeography. 27(1): 105-129.

Minnich, Richard A. 1977. The geography of fire and big-cone Douglas-fir, Coulter pine and western conifer forests in the east Transverse Ranges, southern California.

Minnich, Richard A. 1999. Vegetation, fire regimes, and forest dynamics. In: Miller, P. R.; McBride, J. R., eds. Oxidant air pollution impacts in the montane forests of southern California: a case study of the San Bernardino Mountains. Ecological Studies: Analysis and Synthesis. Vol. 134. New York: Springer-Verlag: 44-80.

Minnich, Richard A.; Franco-Vizcaino, Ernesto. 1997. Mediterranean vegetation of northern Baja California. Fremontia. 25(3): 3-12.

Murie, Adolph. 1951. Coyote food habits on a southwestern cattle range. Journal of Mammalogy. 32(3): 291-295. [25116]

Native Plant Information Network, NPIN (2013). Published on the Internet http://www.wildflower.org/plants/ [accessed: 5/4/2015]. Lady Bird Johnson Wildflower Center at The University of Texas, Austin, TX.

Neff, Don J. 1974. Forage preferences of trained deer on the Beaver Creek watersheds. Special Report No. 4. Phoenix, AZ: Arizona Game and Fish Department. 61 p. [162]

Oesterritter, L. (2020) Mastering Kilns and Firing; Raku, Pit Barrel, wood Firing , and More. Quarry Books.

Ortiz, Beverly R., "Following the Smoke II," News from Native California (Berkeley: Heyday Books), Spring, 1999, p. 13 ff.

Pase, Charles P.; Brown, David E. 1982. Interior chaparral. In: Brown, David E., ed. Biotic communities of the American Southwest--United States and Mexico. Desert Plants. 4(1-4): 95-99.

Pase, Charles P.; Lindenmuth, A. W., Jr. 1971. Effects of prescribed fire on vegetation and sediment in oak-mountain mahogany chaparral. Journal of Forestry. 69: 800-805.

Pond, Floyd W.; Cable, Dwight R. 1960. Effect of heat treatment on sprout production of some shrubs of the chaparral in central Arizona. Journal of Range Management. 13: 313-317. [260]

Porzel, Robert (2021)On formalizing narratives. In Proceedings of the JOWO – Ontology Workshops, Bolzano, Italy, 2021.

QGIS.org (1997-2024). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.org

Richter J (1970) The notebooks of Leonardo da Vinci. Dover, New York.

Roderick, Wayne, "Indian Uses of Native Plants," by Pat McRae, Manzanita (Berkeley: Regional Park Botanic Garden, Tilden Park), Vol. 3, No. 4, Winter 1999.

Seklecki, Mariette T.; Grissino-Mayer, Henri D.; Swetnam, Thomas W. 1996. Fire history and the possible role of Apache-set fires in the Chiricahua Mountains of southeastern Arizona.

Snyder, Gary (1972) Manzanita. Four Seasons Foundation

Seidel et al. (2019) How a measure of tree structural complexity relates to architectural benefit-to-cost ratio, light availability, and growth of trees.

Sone K, Suzuki AA, Miyazawa S, Noguchi K, Terashima I (2009) Maintenance mechanisms of the pipe model relationship and Leonardo da Vinci's rule in the branching architecture of Acer rufinerve trees. J Plant Res 122: 41–52.

Sweeney, James R. 1956. Responses of vegetation to fire: A study of the herbaceous vegetation following chaparral fires. University of California Publications in Botany. 28(4): 143-250.

Toyoshima, Fumiaki, Adrien Barton, Adrien and Jean-Francois Ethier (2022) Affordances and their ontological core. Journal of Applied Ontology, 17(2):285–320, 2022.

Turvey, M.T. (1992) Ecological foundations of cognition: Invariants of perception and action. American Psychological Association, 1992.

Vestal, Paul A. 1952. Ethnobotany of the Ramah Navaho. Reports of the Ramah Project: No. 4. Papers of the Peabody Museum of American Archeology and Ethnology: 40(4). Cambridge, MA: Harvard University. 94 p.

Vines, Robert A. 1960. Trees, shrubs, and woody vines of the Southwest. Austin, TX: University of Texas Press. 1104 p.

Vogl, Richard J.; Schorr, Paul K. 1972. Fire and manzanita chaparral in the San Jacinto Mountains, California. Ecology. 53(6): 1179-1188.

West GB, Brown JH (2005) The origin of allometric scaling laws in biology from genomes to ecosystems: towards a quantitative unifying theory of biological structure and organization. J Exp Biol 208: 1575–1592.

Wiggins, Ira L. 1980. Flora of Baja California. Stanford, CA: Stanford University Press. 1025 p.

York, Darryl L.; Schemnitz, Sanford D. 2003. Home range, habitat use, and diet of Gould's turkeys, Peloncillo Mountains, New Mexico. The Southwestern Naturalist. 48(2): 231-240.

Websites:

https://calscape.org/Arctostaphylos-pungens-(Pointleaf-Manzanita)?srchcr=sc5773788b979e4

iNaturalist. Available from https://www.inaturalist.org. Accessed 2024.

https://calpba.org/rx-fire-events

Conclusion References

Arnoldi, J.F. et al (2015) Resilience, reactivity and variability : A mathematical comparison of ecological stability measures, Centre for Biodiversity Theory and Modelling, Station d'Ecologie Expérimentale du CNRS 09200 Moulis France ´

Carney, J. (2001) Black Rice: The African Origins of Rice Cultivation in the Americas. Harvard University Press.

Coryell, R. (2024) "Why prescribed burns in Summer?" How to balance wildfire mitigation. Sonoma Gazette. July 17, 2024.

Dineen, J.K. (2024) "What happens if California Forever can't build its new Bay Area city? The group has a 'plan B.'" San Francisco Chronicle, June 15, 2024.

Fernanda Moscarelli. Sch´ema de Coh´erence Territoriale (SCOT) et d´eveloppement durable en France : enseignements `a partir des cas grenoblois et montpelliérain. Géographie. Université Paul Valéry - Montpellier III, 2013. Francais.

Fossum, C.A., Collins, B.M., Stephens, C.W., Lydersen, J.M., Restaino, J., Katuna, T. &Stephens, S.L. (2024). Trends in prescribed fire weather windows from 2000 to 2022 in California. Forest Ecology and Management, 562, 121966

Foster, J. B. (2000). Marx's ecology: Materialism and nature. New York: Monthly Review Press.

Mehta, Jonaki (2024) California's newest state park is a time machine. National Public Radio. July 25,2024.

Lathi, Bhagwandas Pannalal: Signals, Systems and Controls. Intext Educational Publisher, New York, 1973-1974.