Drought mending: Experimenting with drought in suburban southern California

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Abstract

This article explores the politics of producing knowledge about drought in a suburban region of southern California: Orange County. Based on nine months of ethnographic research with the assistant specialists that keep the Loma Ridge Global Change Experiment (LRGCE) station running, the article demonstrates how the station, which studies microbial communities and wildfire effects on the local ecology, simply cannot produce the necessary data without these workers' and specialists' expertise and efforts. More than an examination of how drought research happens, this article interrogates how the LRGCE, situated on the Santa Ana mountains and on the ancestral land of the Acjachemen and Tongva peoples, is part of a regime of scientific knowledge production tied to land-use claims. Rather than focus on the science that is produced into valued research products through occupation of Loma Ridge, this article focuses on the forms of repair, tinkering, and maintenance that are near-daily necessities for maintaining the conditions necessary to pull drought knowledge from Loma Ridge and that reveal the various openings where science and land occupation is anything but natural, exposing the relations of settler colonial occupation. Centered on a theory of "mending," this article provides a window into drought's political economy; in particular, it foregrounds the complex relationships between drought and the settler colonial mode of domination that structures southern California's suburbs and the production of scientific knowledge on native lands.

Keywords: Drought, political ecology of water, settler colonialism, southern California, maintenance

Resume

Cet article explore les politiques de production de connaissances sur la sécheresse dans une région suburbaine du sud de la Californie : le comté d'Orange. Basé sur neuf mois de recherche ethnographique avec les assistants spécialistes qui assurent le fonctionnement de la station Loma Ridge Global Change Experiment (LRGCE), l'article démontre comment la station, qui étudie les communautés microbiennes et les effets des incendies de forêt sur l'écologie locale, ne peut tout simplement pas produire les données nécessaires sans l'expertise et les efforts de ces travailleurs et spécialistes. Plus qu'un examen de la manière dont se produit la sécheresse dans le domaine de la recherche, cet article s'interroge sur la manière dont le LRGCE, situé sur les montagnes de Santa Ana et sur les terres ancestrales des peuples Acjachemen et Tongva, fait partie d'un régime de productivité et de production de connaissances scientifiques lié à la terre utiliser des revendications. Plutôt que de se concentrer sur la science qui est produite en produits de recherche valorisés par l'occupation de Loma Ridge, cet article se concentre sur les formes de réparation, de bricolage et d'entretien qui sont des nécessités quasi-quotidiennes pour maintenir les conditions nécessaires au prélèvement des connaissances sur la sécheresse à Loma Ridge, et qui révèlent les diverses ouvertures où la science et l'occupation des terres sont tout sauf naturelles, exposant les relations de l'occupation coloniale des colons. Centré sur une théorie de la « réparation », cet article ouvre une fenêtre sur l'économie politique de la sécheresse ; en particulier, il met en avant les relations complexes

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entre la sécheresse et le mode de domination coloniale qui structure les banlieues du sud de la Californie et la production de connaissances scientifiques sur les terres indigènes.
Mots-cles: Sécheresse, écologie politique de l'eau, colonialisme de peuplement, Californie du Sud, entretien

Resumen

Este artículo explora las políticas de producción de conocimiento sobre la sequía en una región suburbana del sur de California: el condado de Orange. Basado en nueve meses de investigación etnográfica con los especialistas asistentes que mantienen en funcionamiento la estación Loma Ridge Global Change Experiment (LRGCE), el artículo demuestra cómo la estación, que estudia las comunidades microbianas y los efectos de los incendios forestales en la ecología local, simplemente no puede producir los datos necesarios. sin la experiencia y los esfuerzos de estos trabajadores y especialistas. Más que un examen de cómo ocurre la sequía de investigación, este artículo interroga cómo el LRGCE, situado en las montañas de Santa Ana y en la tierra ancestral de los pueblos Acjachemen y Tongva, es parte de un régimen de productividad y producción de conocimiento científico ligado a la tierra. afirmaciones de uso. En lugar de centrarse en la ciencia que se convierte en valiosos productos de investigación a través de la ocupación de Loma Ridge, este artículo se centra en las formas de reparación, retoques y mantenimiento que son necesarios casi a diario para mantener las condiciones necesarias para extraer conocimientos sobre la sequía de Loma Ridge y que revelan las diversas aperturas donde la ciencia y la ocupación de la tierra son todo menos naturales o ajenas a las relaciones de ocupación colonial de los colonos. Centrado en una teoría de la "reparación", este artículo ofrece una ventana a la economía política de la sequía; en particular, pone en primer plano las complejas relaciones entre la sequía y el modo de dominación colonial que estructura los suburbios del sur de California y la producción de conocimiento científico en las tierras nativas.
Palabras clave: Sequía, ecología política del agua, colonialismo, sur de California, mantenimiento

1. Introduction

I am standing atop Loma Ridge (33°44' N, 117°42' W, 365 m elevation), an Orange County, California, grassland ecosystem and nature preserve tucked away in the Santa Ana Mountains. It is the spring of 2022. Accompanying me are land managers, local conservationists, and University of California and California State University researchers. From our perch, the view extends southward, letting us see across the city of Irvine all the way to the coastal bluffs and marshlands that surround the UC Irvine campus. If I look closely, beyond a thin layer of smog, I can also pick out Catalina Island in the distance. Our focus today, however, is on something much closer: several alien-like structures that jut out of the canyon like great metallic rib cages. Their purpose? To better understand how drought conditions will impact the local ecology and, by extension, human communities across southern California. Together, these structures comprise the Loma Ridge Global Change Experiment (LRGCE) station (Figure 1), which is managed through a partnership between UC Irvine and the Irvine Ranch Conservancy. The stated purpose of this site contrasts with the suburban communities at the foot of Loma Ridge, whose water-intensive lawns and ever-increasing population place a mounting burden on water resources.

The start of 2022 had sucked the air out of the room, so to speak, when January and February became the driest on record, officially starting the Golden State's third consecutive year of severe drought (Smith, 2022). In preparation for summer, the Metropolitan Water District of Southern California announced the strictest water cuts in its history (James, 2022). The reason: its water supplies, half of which are from the State Water Project, which draws from Sacramento and the San Joaquin River Delta, and the other half from the Colorado River, appeared no longer capable of sustaining the state's Central Valley farmlands or satiating the verdant desires of southern California homeowners (Smith and James, 2022). The L.A. Department of Water and Power made a two-day-a-week watering regimen official on June 1, 2022. Touted as a large success, L.A. residents reduced water usage by as much as 11% in July, the peak summer month (Smith and James, 2022). Water restrictions, however, dominoed well into the early winter of 2022, with the Metropolitan Water District declaring a continued regional drought emergency on December 14, for fear that extended drought would affect water reservoirs well into the future.

For southern Californians, drought has become a way of life. Everywhere, it is a common topic of conversation. Some vent: "can you believe the new watering restrictions?" Others search the clouds and note, optimistically: "looks like it might rain." Those who live in southern California know this song and dance well. As 2022's water restrictions placed drying rivers and reservoirs, seemingly worlds away from southern California, at the feet of people's homes, it changed how we think about doing laundry, washing dishes, and yes, watering the region's increasingly maligned lawns. The state came out of a historically wet 2023 winter, amplifying extremes of climate variability driven by climate change that mean rainy periods are not mutually exclusive to prolonged regional drought (Shao, Rojanasakul, & Popovich, 2023). This was evident with Governor Newsom's March 2023 easing of water conservation efforts that allowed many of the state's suburban communities to return to a less restrictive watering regimen, even as drought still looms large on everyone's mind.

Figure 1: A drought shelter at Loma Ridge Global Change Experiment. Photograph by Author

It is against this context – of drought amid extreme climate variability and southern California's water-intensive suburban sprawl – that a widening array of actors have sought involvement in the LRGCE. Whether hailing from land management, biodiversity and conservation, or academic research standpoints, all those I stand among atop Lome Ridge in the spring of 2022 have come to better understand the material, ecological, and political ramifications of expanding regional drought. We listen as Mike Goulden, UC Irvine professor of Earth Systems Science, describes how he, along with his colleague Katie Suding, established the research station in 2007 to measure the impact of drought on the region's plants, humans, and non-human animals. Before passing the conversation to his Earth System Science colleague, and current runner of the LRGCE, Steven Allison, Goulden gestures to the valley below, indicating where "two years ago, a fire came up this ridge and burnt the drought shelters and the experiments that Steve had been running." We could see all around us the scorched remains of coastal sage scrub, with some of the structures still in need of repair following the 2020 Silverado fire.

Figure 2: A shrub crowning after the 2020 Silverado Fire. In the background, suburban sprawl. Photograph by Author

Flash-forward a couple of months from that initial partner meeting at the LRGCE. Now, it is autumn, and I am accompanying Moises Perea-Vega, a Junior Research Specialist at UCI Nature, the university's umbrella program overseeing research, education, and public engagement on the environment and natural resources, doing his work on Loma Ridge. Perea-Vega directs a small undergraduate team of volunteers on how to use a power drill to remove burnt PVC pipe from one of the LRGCE's drought structures. Suddenly, a distracted student asks about a stout shrub nearby that is seemingly growing from within the burnt remnants of another (Figure 2). "It's the same one, it's crowning," Perea-Vega notes dryly before continuing, "The fire burns above ground, creates the proper heat and soil conditions, and the shrub germinates again but from below ground; from its center." To which the undergrad responds, "oh, it's on the mend."

To me, it seemed that the curious undergraduate student found a metonym in the chaparral. They made visible what Perea-Vega does to make the LRGCE viable as a research station: mending work. Of course, field researchers like Perea-Vega and his colleague, Julie Coffey, UCI Nature Lead Research Specialist, don't just mend, they do the constant and long-term work of running the drought experiments on the LRGCE. The latter, however, depends on the former. More specifically in the case of these individual scientists, they produce and collect data from the Loma Ridge ecology about microbial communities, which can tell us a great deal about what a future of drought may entail for the southern California region and beyond; yet this research would not be possible without careful attending to the burnt drought structures. Moreover, myriad volunteers who perform ongoing caretaking of the LRGCE, including coming together at a moment's notice to cover the drought shelters when rain is expected, also participate in mending work when they repair damage to the station caused in the wake of wind, rain, and firestorms. And as you might have guessed, keeping this reparative cycle of mending going, which is so crucial to facilitating the research and knowledge production that happens here, requires tons of work.

This article explores the work of drought mending. In the face of drought's dire implications for entire ecosystems and the beings that rely on and shape them, scholars working in and across the physical science, engineering, and social science disciplines have approached drought from many directions. Many have tried to pin drought down by using "big data" (Balti *et al.*, 2020) others have turned to remote sensing (West, Quinn, & Horswell, 2019); monitoring conditions from local to global levels (Hao *et al.*, 2014), some have even created metrics and indexes for the quantification of drought (Sun *et al*., 2022; Shah & Mishra, 2020). Much of the anthropological literature on "water (in)sufficiency," as Andrea Ballestero (2019) terms it, has focused on scarcity and water excess through the lens of infrastructure, with McCabe and Quandt (2019) pointing out its tendency to center a dyadic focus on hazard and resilience. Different than the literature, this article's focus on mending turns to the everyday activities of maintaining what is required to produce knowledge about drought in the face of drought's widespread intractability.

Mending, I argue, enables a better understanding of drought's political economy; in particular, it allows me to foreground the relationships between drought and the settler colonial mode of domination that structures southern California's suburbs. As Max Liboiron (2021b), citing Glenn Coulthard (2014), explains, settler colonial domination is a set of "relationships characterized by conquest and genocide that grant colonialists and settlers' ongoing state access to land and resources that contradictorily provide the material and spiritual sustenance of Indigenous societies on the one hand, and the foundation of colonial state-formation, settlement, and capitalist development on the other" (p. 9). Specifically, I deploy ethnographic methods to investigate the settler land relations created—and maintained—through the routinized and laborious efforts that are being used to draw drought knowledge from Loma Ridge, where mending epitomizes the devalued work and deep knowledge that is so often excised from the circuits of scientific value production. Powerfully, a pause to focus on drought mending also presents opportunities to destabilize naturalized settler domination over land relations and offers a nuanced picture of the social, political, and ecological meaning behind drought and its study in the region.

This article is based on nine months of ethnographic research conducted across various sites related to the production of drought research in suburban southern California, focused on the community around Lome Ridge. This research consisted of field visits to the LRGCE, and included time spent with field researchers, undergrads, graduate students, and postdocs. Throughout, I spent time with land managers and conservationists and attended in-person and virtual LRGCE planning workshops led by Loma Ridge stakeholders and the Allison Lab at UC Irvine. Methodologically, I situate ethnographic research alongside archival material and land histories of Loma Ridge to grasp at a drought horizon that, even if intractable, is still approaching (Wilhite, 2000).

2. Loma Ridge: a history

The first day that I visited the LRGCE to pitch in with the mending work necessary to repair fire damage from the Silverado fire, I tripped—hard—on what I thought was a rock. Perea-Vega leaned in for a closer inspection. Grabbing at the ruddy mound of soil, he unfurled a small segment of a rusted chain. It had imperfect and rough-edged links and was most likely returned to the surface by the recent storms. "It certainly is not anything brought up by us or other researchers in the last two decades, it's probably from the cattle ranchers," noted Perea-Vega. What he is rightly referring to is how most of the area, stretching from Santiago Canyon Road to the north and the 241 Toll Road to the west, was historically used as grazing land for sheep and cattle. It was this enclosure making process of ranching that, up and down California, created settler land claims through the enforced displacement and genocide of native tribes. This began under the carceral regimes of forced labor of the Spanish friars (Madley, 2019; Hernández, 2017), continued among the Californios, who held the land through anti-Native violence and the Mexican Land Grant system (Gómez, 2019; Sánchez, 1995; Sánchez & Pita, 2021), and then enriched white US speculators, ranchers and, later, land developers. Today, entities from gated communities to the conservancy that helps oversees the LRGCE bear the word "ranch" in their title, a reminder of this long history of settler colonial enclosure in the name of profit-making at the expense of Indigenous inhabitants and their relationships to land.

The region known today as Orange County is the ancestral home of the Acjachemen people, also known as the Juañeno Band of Mission Indians. Their village communities extended to northern San Diego and southern Los Angeles, living alongside neighboring Tongva and Luiseño tribes to the north and south, respectively (Gilio-Whitaker, 2019, 132). During the Mission Period of the late 18th century, friars anchored southern California missions through cattle ranching and steadily advanced genocidal violence against the Acjachemen people. Mexican secularization of the missions occurred through the land grant system in 1833, which further advanced ecological, land, and anti-native violence, and led to Loma Ridge becoming the property of the Lomas de Santiago Rancho, a 47,227-acre (19,111 ha) land grant given to Teodosio Yorba in 1846 by Mexican Governor and Californio Pio Pico. As a result of financial troubles and a historic drought that gripped the region and decimated Californio ranching, Yorba sold the Lomas de Santiago rancho to William Wolfskin in 1860, who then sold the land to three ranchers in 1866, among then James Irvine (Schiesl, 1991, 56). These men also bought bordering Rancho San Joaquin and a portion of Rancho Santiago de Santa Ana. In 1867, Irvine bought his partners out to take over the whole ranch. Although he passed away just a decade later, the lands fell into the hands of his son, James Irvine II. Soon after the incorporation of Orange County from the southern portions of Los Angeles in 1889, the junior Irvine incorporated his land as the Irvine Company (Schiesl, 1991, 56). Under his helm, the Irvine Company continued ranching and began agricultural production, including the region's eponymous citrus (Gonzalez, 1994). Toward the middle of the twentieth century, the Irvine Company all but left ranching behind for real estate development. It sold some of its land to the UC Regents for the establishment of the University of California, Irvine and granted other parcels of land to the County of Orange, much of which is now managed under Orange County Parks.

On Loma Ridge, grazing, somewhat surprisingly given the deep suburbia of Irvine, has been used to assert settler land claims as recently as the early 2000s. In 2002, the Irvine Company, already mostly disinvested from ranching, finally rounded up its last cattle and dismissed its last cattle hands, to make room for a 6-lane expansion to Jeffrey Road, the primary access road for Loma Ridge today (Wilson, 2002). Collecting the last head of cattle at the start of the new millennium marked the Irvine Company's symbolic *fait accompli*, even if quietly, from ranching business to full blown land development company—now best known for the creation of what Kling, Olin, and Poster (1991) have called the "postsuburban system," a form of planned development focused on "commercial specialization, technological expertise, and much residential homogeneity and self-sufficiency" (p. 55). This form of planning is quite evident at the foot of Loma Ridge at the Jeffrey Road and Portola Parkway junction, where new high-end housing development flanks either side of the two-lane restricted access road you travel along to gain entry to the LRGCE and Loma Ridge. From here, you can observe various large transport trucks driving down the small two-lane road and hauling building materials from a nearby asphalt plant carved into the canyon that makes much of the region's nearby development possible.

My first trip to the LRGCE required that I secure permission to enter by registering my vehicle with the Irvine Ranch Conservancy (IRC), a land steward organization that manages Orange County open spaces on behalf of various landowners, including Orange County Parks and the Irvine Company. I then made my way to a metal access gate that opened to an ascending windy, albeit short, drive to the LRGCE, punctuated by great canyon views with colorful artemisia (daisy), mallow (Malva sylvestris), and toyon (Heteromeles arbutifolia) just off the roadway. The station has been in operation since 2007, when UC Irvine researchers Michael Goulden and Katie Suding began experimenting on the impact of precipitation change, nitrogen, and fire on the local ecosystem. Now, the LRGCE is managed by the Allison Lab, led by Steven Allison and his team of undergraduate, graduate, and postdoctoral researchers. Together they study how microbial communities, and their related ecosystems, respond to drought and climate change by tracking their soil carbon and nutrient cycling—how microbes decompose organic material in times of ecological stress, like with droughts (Matulich *et al.*, 2015; Martiny *et al.*, 2017; Malik *et al.*, 2020; Allison *et al.*, 2013).

While the cattle chain that I tripped over is a remnant of multiple forms of overtly colonial land-use practices on Loma Ridge, the reason I was up there was linked to Loma Ridge's current use by and for UC Irvine, a land grant university that is part of a federal system established through the Morell Act of 1862, which anchored the country's public higher learning institutions through the theft of thirty thousand acres of native lands (Marez, 2019, 21). Marez (2019) has succinctly outlined UC Irvine's land grant history and its knotty relation to the Irvine Company:

> Reagan's speculation in Indigenous lands extends to the UC system and his efforts to acquire land for the building of UC Irvine. Reagan's personal lawyer, closest adviser, and UC Regents appointee, William French Smith, was also the lawyer of the Irvine Company, which in the mid-1960s owned 130 square miles [33,670 ha] of ranch land in Orange County. When the company donated 1,000 acres [405 ha] to the state for a university, it secured a substantial tax break that became the seed money for the settlement of the city of Irvine (p. 83).

The LRGCE, through the land claims of the settler land grant university system, is part of a settler scientific regime that draws drought knowledge from Loma Ridge and that is underwritten by a history of Spanish, Mexican, Californio and US settler ranch and land development.

3. Land and labor in the settler 'scientification' of Loma Ridge

The colonial land politics undergirding the settler production of science at Loma Ridge are themselves deeply imbricated in wider phenomena of drought and related issues of ecological mismanagement, resource scarcity, and climate emergency. The US settler state has appropriated water, rivers, streams, oceans, and lakes, to assert power and control over land and to expand economic interests at the direct expense of Native communities' lifeways (Yazzie & Risling Baldy, 2018).

For example, Goeman (2017) notes how the 1979 Hydro-Quebec project displaced Inuit and Cree communities and dammed rivers to provide power to the US and create an economic foothold for the province of Quebec (p. 105). Also, the Navajo Indian Irrigation Project, which, as Bray (2021) notes, was meant to develop family farming and alleviate poverty on the Navajo Nation, served "as a mechanism to appropriate Native water resources [the San Juan River] for use in white communities" (p. 587). Correia (2022), in the context of South America's Chaco, theorizes "settler waterscapes" to explain how settler logics of elimination, enacted through "waterscape change" and environmental violence, "disrupt Indigenous systems of relations and responsibilities and thus undermine the ability to live well" (p. 1891). Claire and Surprise (2022) similarly offer the concept of "hydrologic rift" to describe the disruption and enclosure of Native land and water resources for the advancement of state and capitalist interests; a process of "reclamation," which creates private property through "the destruction of Indigenous ecologies, nonhuman relatives, and kinship networks" (p. 156). Drought, as a facet of ongoing settler colonization, is not a natural disaster, slow as it may be (Ballestero, 2019), but is instead better described, as Woods (2017) does, as a result of concerted historical (settler colonial) processes that steal land and dispossess Native groups. Images of drying rivers and reservoirs aside, drought is not especially spectacular—even if the image of drought-stricken suburbia certainly is.

For Orange Countians, managing the financial and domestic fallout of drought is an exceedingly mundane part of being a political actor—especially when water bills continue to increase year after year. For example, the conservative bastion and water-guzzling, equine-friendly suburban enclave of Yorba Linda (birthplace of Richard Nixon) was hit with a state-imposed 36% water reduction mandate during the drought in 2015 that tripled service fees meant to offset a reduction in water sales that normally cover necessary salaries and water infrastructure maintenance. It took no time at all for residents to launch a recall against two water district board members (Sforza, 2016). Under the current drought, water use in the city of Anaheim is driven by Disneyland, which, given its deep suburban political history (Avila, 2004) and carefully crafted imaginary of the white suburban nuclear family on Main Street (Avila, 2021), belies a water-consuming hotel and park infrastructure (Sforza, 2022). While different, both examples point to the outsized role that suburban development and the suburban imagination—and their attendant politics—play in shaping water resource management, public use, and fulfilling the unsustainable aesthetic desires in Orange County. They also obscure suburbanization as the historical and social formation that exacerbates drought in the county and region today (Vine, 2018; Gober *et al.*, 2013). As a result, the water intensive needs of the region are universalized as "everyone's problem, " reinforcing a "settler move to innocence" (Tuck & Yang, 2012) that continues to undergird settler colonial dispossession and Native elimination.

This has not meant that Native communities are passive actors in the region's suburbanization imperatives that are directly tied to drought. But it has shaped what kinds of ecological and political landscapes

Native actors must navigate, as well as the possibilities for coalitional activism. Orange County's growth has required infrastructure, including but not only water-related infrastructure, to keep pace, resulting in settler colonial "solutions" of various types. For example, in 2006, the Transportation Corridor Agencies sought to build a toll road with the aim of providing commuters with a private road option for the Golden State Freeway between San Diego and Orange Counties. The proposed plan was to cut through the San Mateo Creek watershed, the location of the largest ancestral village of the Acjachemen tribe, known as Panhe, "the place at the water." As it happened, the toll road also jeopardized the nearby world-class Trestles surf break in San Clemente. Significant opposition to the project quickly mounted, with local surfers launching a campaign that garnered national attention and came to include Acjachemen tribal members organizing as the United Coalition to Protect Pahne (Gilio-Whitaker, 2019, 134). Together, activists rallied behind environmental studies that showed that the proposed 241 toll road extension would unequivocally alter the famous surf break by tearing up the creek bed and disrupting the flow of water (Gilio-Whitaker, 2019, 133). In the end, activists and the United Coalition to Protect Pahne successfully put a stop to the toll road and protected Pahne ancestral sites. This resulted in a process that enabled the Acjachemen people, who are not federally recognized and thus do not have protected rights to their culturally important lands, to "expand their ceremonial use of Panhe while they worked to protect it" (Gilio-Whitaker, 2019, 134).

Still, for Gilio-Whitaker (2019), the political action against the Transportation Corridor Agencies revealed not just an unlikely coalition but a synergistic and ironic outcome: "Panhe was protectable *because* of its absorption into what eventually became publicly owned or leased lands, subject to laws designed for the homogenized masses that comprise the American public, not necessarily or primarily because of its inherent meaning for Acjachemen people" (p. 137). Ongoing research at LRGCE brings up similar complexities when it comes to recognizing Native groups' existing relations to the land and striving to create opportunities for Native involvement on the ridge, even if prior attempts at doing so have been few and far between. Of course, it is necessary to note that the LRGCE's running of drought experiments on Loma Ridge is, in part, how public land use and the land grant university advance settler occupation.

Consider, for instance, the following example. In the spring of 2022, Steven Allison convened land management and conservation groups, various researchers from throughout the UC and CSU systems, as well as local educators and environmental justice stakeholders for a two-day workshop. The aims of this workshop were to create a strategic 5-year plan for the LRGCE and to expand knowledge about the impacts of regional and global drought. At the top of the priorities list was identifying how to secure the LRGCE's long-term viability on Loma Ridge, "opening up" the station to local communities for drought research and programming and seeking to support native land relations on the Ridge. Across the two days, there were various presentations, breakout sessions, end of day visioning, and even a fieldtrip to the LRGCE facilitated by Irvine Ranch Conservancy (IRC), who manages the Loma Ridge open space. Tribal groups, however, were notably absent during this early-stage meeting, highlighting the primary challenge behind Native community participation with the LRGCE, which is more broadly and deeply connected to the challenges and extractive histories of tribal consultation and collaboration (Richland, 2021) with state entities like the settler land grant university.

The fate of the LRGCE is decided by the landowners of Loma Ridge who make the final decision on how the land there will be used, and therefore must attend to such priorities. To that end, findings from the workshop, crucial for keeping the LRGCE in operation, highlighted the LRGCE's strong documented history of research production, which they presented as providing an opportunity for connecting to new educational entities, community and tribal groups, and funders. Tempering these claims to strengths, however, were the LRGCE's operation costs of US$150k a year as well as issues of accessibility that compound a lack of meaningful connection to Native communities. While the LRGCE is open to the public in the technical sense, it is difficult for community members to gain access to Loma Ridge. Not only is the station hard to find, but access requires formal permission from the IRC. And, if in a large group, the IRC must coordinate the shuttling of visitors to the station in a converted pick-up truck with seats on its bed (think *Jurassic Park*). The issue of access is, of course, a problematic paradigm for Native groups whose stolen land is converted into public land use for "everyone." This is particularly complex for the Acjachemen peoples, whose lack of federal recognition means they do not have rights under federal law that might otherwise protect their access to culturally significant sites (Gilio-Whitaker, 2019, 133).

People at the workshop articulated a strategy to move forward by considering how to include tribal groups by honoring tribal connections to land beyond an "access" paradigm that, as Byrd (2011) has argued, often sidesteps how "colonization of indigenous lands […] cannot be ended by further inclusion or more participation" (xxvi). This is particularly important given the concern that tribal consultation can devolve into the appropriation of tribal time, resources, and intellectual labor for the land grant university, landowners, and developers, who, by allowing the LRGCE to operate on Loma Ridge, gain political and economic forms of social capital that deepen settler land occupation. After all, colonialism, as Liboiron (2021b) notes, is not a monolithic structure that has "roots exclusively in historical bad action, [but is rather] a set of contemporary and evolving land relations that can be maintained by good intentions and even good deeds" (p. 6). For those who are "at the table" to think about the future of the LRGCE, Liboiron's point has significant implications: plans to increase access and inclusion must grapple with the fact that attempts to pull drought knowledge from Loma Ridge are never outside the land relations of settler colonialism—no matter how well intentioned.

Conducting drought research does not happen outside of land relations. As Liboiron (2021b) notes, "science always happens within land relations, and those relations are always specific to that place" (p. 246). Yet it is also the case that settler colonial science destroys place-based relations through systems of rationalization geared toward the production of variables, "elements of the environment as discrete, autonomous actors" (Liboiron, 2021b, 48). This is a process of enclosure that makes land and its relations subservient to property and capitalist relations (Tuck & McKenzie, 2014) as well as to scientific knowledge production. The LRGCE brings to light the growing unsustainability of life in southern California due to expanding regional drought; but as the occupation of land is necessary, not marginal, for the scientific production of drought knowledge here, can the LRGCE be used to advance anticolonial research? Liboiron (2021b) identifies anticolonial research as "knowledge systems, sometimes arrayed with, sometimes adjacent to, and sometimes explicitly against the knowledge systems of dominant science" but that do not explicitly have the goal of decolonization (i.e. giving the land back) (p. 133). Ultimately, the imperative of doing anticolonial science at LRGCE will require supporting tribal communities' existing relationships to land in the region, resulting in an opportunity most likely not available otherwise through development initiatives that aim for "public (non-native) access" by landowners.

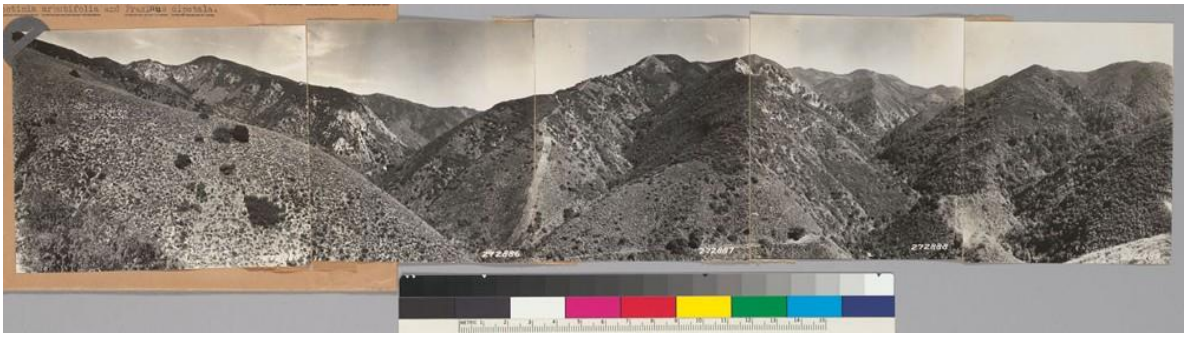

Figure 3: A view of Silverado Canyon taken in 1931. Berkeley Library, Weislander Vegetation Type Map Survey Collection

Just as conducting drought research does not happen outside of land relations, it also does not happen outside labor relations. To consider not only drought but also how scientific knowledge is created *about drought* involves interrogating the labor undergirding how it is maintained as a colonial construct and material process of ongoing Native dispossession. As such, to theorize an anticolonial science for the LRGCE requires denaturalizing the labor process of drawing drought knowledge from Loma Ridge, which brings us to the work of mending as a category of analysis.

On March 31, 1931, a series of photos were taken of Silverado Canyon from atop Loma Ridge. Whoever held the camera that day aimed it at roughly the same hills that those present on the LRGCE field visit were asked to imagine on fire. Part of the Albert E. Wieslander Vegetation Type Map (VTM) Survey Collection, these five photographs contributed to an effort to record California's unique vegetation. The VTM survey was funded by the U.S. National Forest Service, and later the Works Progress Administration (WPA), with the aim of supporting "statewide land use and fire protection policy development." The VTM survey ran from the mid-1920s to the 1930s and required boots on the ground to complete its significant geographic undertaking. Today, these data sets, which cover over 13,000 sample plots across California and total over three thousand photographs and hundreds of detailed hand-drawn vegetation maps, continue to be widely used, including by those researching water and drought.[2] Whoever took the photographs also documented the region's vegetation in their field notes, noting the California sagebrush (artemisia californica) and white sage (salvia apiana), as well as the chaparral hoaryleaf ceanothus (ceanothus crassiolius). These notes were later added to Wieslander's official (and massive) Field Guide for the VTM survey. I like to imagine that this now anonymous field researcher on Loma Ridge, nose to the grindstone, recording all manner of vegetation and topographic data, may also have noticed the swiftly changing panorama of Orange County social relations.

In an interview late in his life, Wieslander remarked on the important but unheralded position of the workers who spent days in remote locations across California recording the data necessary for the VTM survey:

> [With] the WPA. We were able to put on both professionals and a lot of other [people.] We got professional people but they didn't get professional pay. We got a lot of office help. We were able to undertake a lot of work that otherwise couldn't have been done […] there was what were called junior assistant technicians. We got two of them, and both turned out quite well (Lage, 1985, 117).

Wieslander's comments say a great deal about the hierarchies of settler science and the labor necessary to produce knowledge about the ecology that could then aid in settler land-use and planning. I invoke Wieslander's honest assessment of the devaluation of the labor of "junior assistant technicians," whose efforts were at the core of the VTM survey, because of what it reveals about the centrality of labor to settler colonialism's ability to convert land into a resource to be catalogued and extracted— isolated plants scribbled on field notes divorced from their ecological and Native and land relations.

Today, drawing scientific data from Loma Ridge requires the LRGCE to implement regimes of labor that are differentially valued by the internal hierarchies of academic knowledge production. Academic products, like articles and grants, are at the forefront of this regime of value. Most valued and privileged within those products are the voices of faculty researchers, postdocs, and graduate students—though obviously to different degrees. In the so-called "hard sciences," knowledge products depend on entire regimes of labor that happen in "the lab" or in "the field" or in various other sites where research assistants, paid (albeit often poorly) employees, manage the daily functioning of experiments and data collection. Their work might look like caring after petri dishes, running experiments on non-human animals, or, in the case of the LRGCE, gathering the decomposing organic matter. Their labor, however skillful as it may be, is pushed to the margins; their efforts turned into data points; their participation limns the finished products of research. This labor is central, particularly in its devalued erasure, to the naturalization of settler land occupation even as worker-researchers' efforts might expose the various internal hierarchies of value behind scientific knowledge production that purports to be for "the public," for everyone.

In 2019, UCI Nature adopted the LRGCE as one of the sites that it services. Since then, Julie Coffey, UCI Nature Staff Research Associate has served as lead research specialist for the LRGCE's research operations and maintenance. Coffey, who has been at UCI Nature for five years, admits with a chuckle, "we didn't realize

[2] The Weislander Vegetation Type Map Survey Collection (VTM) sets are digitally housed at the UC Berkeley Library https://guides.lib.berkeley.edu/Wieslander.

quite how involved it would be. There are a lot of moving parts to studying drought; to running this place day in and day out." Coffey then adds:

> We must replicate the conditions for long-running experiments in a very challenging environment. Ecology work is super hacky; everything breaks down and requires constant repair with what we have at hand. This means making sure that the infrastructure of the site is running properly because we are on storm and fire watch year-round, and given the ongoing drought, we must be able to respond with a lot of flexibility. We must quickly mobilize volunteers to activate drought shelters, ensure that water is being diverted and collected into our cisterns for water treatments for those who run litter pouch and microbial experiments. If there is a fire, then we adapt as quickly as we reasonably can to bring the site back up to speed.

When I ask what kind of unique perspective all this work provides her and her colleagues, who she refers to as a "hacky bunch," she responds: "We see the site and the ecosystem up close, we live it. We must work with drought conditions and the challenges it brings; ironically, so that we can assist in producing research on drought."

I've come to understand Coffey's claim that field researchers "live it" to mean not just the unending work of running and mending the site but also how they gain lived experience from time spent with boots on the ground that then inflects their field research expertise. So, when I follow up by asking what all this mending does for the research, for data collection, Coffey doesn't miss a beat: "it helps us be better field researchers. These things are not separate; neither are the research findings; they are also connected to our everyday work." For Coffey, their day-to-day efforts to make the LRGCE viable are necessary to produce "good" data. When I press Coffey on why the exhaustive work they undertake isn't made visible or incorporated as part of the drought knowledge created at the LRGCE, she has a dry response: "because that's science as usual, it's not unique to the LRGCE, but, as a team of collaborators, we are now attempting to think more deeply about the work behind science." After all, Coffey has me understand, if you are incorporated into the research and analysis process more deeply, you'll better be able to reproduce the necessary and optimal conditions for data collection from the field – "you collect better if you know what you're doing it for."

It strikes me as powerful, then, when I pick up on a sense of alienation expressed by Coffey and one of her colleagues about what they identify as the irony of "collecting data and never seeing it again." They make sure to clarify, however, that they don't mean that they lack access to research findings; of course, they do, and they make sure to stay abreast of all the research produced by the LRGCE. They don't even mean that they somehow feel like they don't meaningfully participate as members working alongside the Allison Lab. Instead, they are pointing to the structural systems of scientific knowledge production that have long marked the position – *their* position – as field researchers. Field researchers, they note, are not expected to shape the analysis of data. This, Coffey notes, is partly a result of not having the time: "when there is a choice between maintaining the structures or dedicating some time to analysis, one is explicitly funded by a grant and the other is not. Any analysis or involvement in the end products therefore has to happen in the off times, which are few and far between." As workers, the field researcher is meant to enable the collection of data that "experts" then run for their analyses and conclusions. In the end, the analysis divorces their work and efforts while producing the valued product for publication and grant applications.

Notably, this process in some ways parallels the kind of sidelining, devaluing, and marginalization of Indigenous Knowledge – that is, the '"responsibility-based' and relational sociospatial worldview that differs from dominant anthropocentric 'rights-based' frameworks informing human-environment relationships" (Sioui, 2022, 4). This of course builds on a long history of settler scientific use of Indigenous guides and informants to advance projects of "discovery" and conquest that goes back centuries. But the devaluation of Indigenous Knowledge is also ongoing in the contemporary connected circles of research, academia, and policymaking, including in environmental and earth systems science disciplines despite the long history of more sustainable environmental stewardship among Indigenous communities (Wheeler, *et al.*, 2020). And when it is taken up, as Liboiron (2021a) notes, it is done by "using Indigenous knowledge to enrich non-Indigenous learning [making

it] a core component of colonial knowledge systems that require local knowledges to survive and flourish on colonized land" (p. 876).

To deeply engage in a more collaborative method of doing science, UCI Nature, the UCI Center for Environmental Biology, and the UCI Masters in Conservation & Restoration Science have formed The UCI Environmental Collaboratory. The aims of the collaboratory are as follows:

1) to link academic research with conservation, restoration, and stewardship of natural systems;
2) to promote immersion in nature in order to enhance appreciation, understanding, and respect for natural processes;
3) to educate the next generation of environmental scientists and stewards

This effort seeks to build horizontal research relationships that foster, as Coffey put it, "an environment to voice your ideas and that takes seriously what we are calling 'equality weighted by experience.'" Coffey explains that the Collaboratory is putting forward an alternate register of value that centers the everyday experience and expertise of field researchers, as well as their deep ecological knowledge. For Coffey, the effort is to create and sustain a field of horizontal relationships in research because "hierarchies blind you to what you are doing."[3] This is particularly true for field researchers whose participation is excluded from research analysis and becomes the "never seeing it again" outcome mentioned earlier. I cannot help to think of the parallels and how the onus is once again on field researchers to repair and fix, to tinker. This time they are seeking to open the university's broken research ecosystem that devalues their labor and expertise.

Tinkering with the scope of their members' labor is crucial to the Collaboratory's efforts to reshape the research process. To make sure that their members can receive research training, they catalogue everyone's work schedules to identify "flex hours" where field researchers can gain access to paid professional development aimed at integrating their existing skills into research programs. This effort takes seriously the value behind field researchers' experiential labor and expertise. Members consider their labor as an avenue to destabilize the hierarchies behind producing ecological knowledge, and as a simultaneous intervention into the various devalued economies behind the production of drought knowledge.

In the ethnography of the mending process that follows, I ask how the LRGCE can undertake forms of anticolonial science that might present "points of friction and opportunities for doing science otherwise" (Liboiron, 2021b, 133; 40). Central to this is querying how mending might chart the relation between the work that gets done at the LRGCE and the hierarchies of value that sustain the production of drought knowledge. In addition, the ethnography will show how mending the LRGCE serves to reproduce settler land claims, but might also denaturalize regimes of labor, science, and land occupation.

4. Drought mending

I was having dinner with my family when I got a message from Perea-Vega notifying me that the polyethylene film cover (referred to as plastic tarp, hereafter) was going to be retracted from the drought shelters the following morning. He asked if I wanted to help with the work. Three days earlier, in preparation for an early winter storm, a crew of volunteers had gone to the LRGCE to cover drought plots with plastic tarp to reduce annual rainfall by 50% over what those in the station's ambient (uncovered) plots receive (to mimic drought). In all, the LRGCE has 48 plots in grassland and coastal sage scrub environments. The former is defined by the presence of non-native annual grasses, like bromus diandrus, while the latter is primarily native drought-deciduous shrubs, like artemisia californica (Barbour *et al.*, 2022, 2). Of those 48 plots, 16 plots are in ambient conditions, 16 plots are under drought conditions, and 16 plots undergo water treatment. As you can tell from the staggering number of shelters, field researchers and volunteers are crucial to successfully operating the LRGCE drought experiments.

[3] Coffey gives credit to Sarah Kimball (UC Irvine), Megan Lulow (UC Irvine Nature, Executive Director) and Jennifer Long (Masters in Conservation & Restoration Science, Director) for creating a non-hierarchical approach as part of their commitment to environmental sciences and data collection at UC Irvine.

Figure 4 & 5: A drought shelter (left), and rain gutter (right). Photographs by Author

The next day, I arrived at the LRGCE just after 9am. Already, there was a crew of field researchers from UCI Nature, staff, faculty, graduate students, and postdocs from UCI Earth System Science. I grabbed rattlesnake gaiters to wrap around my shins and a pair of heavy work gloves from UCI's Department of Ecology and Evolutionary Biology's red F-150 pick-up truck. I made my way to the site and helped uncover one of the drought shelters in the coastal sage scrub treatment blocks (Figure 4). As you can tell, they are quite large (18.3 m ×12.2 m) and require many volunteers, like me, to wrangle all the moving parts.

Describing the shelters is a little tricky; so, I'll start by having you imagine how covering the drought shelters works. In this scenario, we begin at the middle of the ribcage and work outward (Figure 4a). There, two lengths of metal pipe, outfitted with PVC, hold the tarp in place. Using carabiners, a rope is attached to the end of each length of pipe to pull the tarp over the shelter's rib cage. The metal pipe eventually comes to sit in an elevated gutter (Figure 5). Rainwater slides off the tarp and collects in the gutter. It then drains into a network of 4 inch (10 cm) pipe connected to above ground cisterns on the perimeter of the LRGCE. The water from the cisterns is then recycled for the plots undergoing water treatment.

Figure 6 & 7: Retracting the tarp (left) and tying the tarp down (right). Photographs by Author

To retract the tarp from the shelter, a rope is again attached to the end of each metal pipe. Two people must pull on opposite ends to retract the tarp into the middle of the shelter (the center of the ribcage) (Figure 6). The same is repeated for the other side of the shelter. Then, both tarps are secured via a slipknot at the center of the shelter (Figure 7). In all, it takes a little over 3 hours to uncover the shelters in the coastal sage scrub environments. On that day, we finish just before the crucial 11am cut-off time, which, "like clockwork," ushers in strong winds that make it much more difficult and dangerous to maneuver the tarp and the shelters' various metal components,

something that Perea-Vega tells me he learned the hard way but that now has led to the implementation of a rule that requires a minimum of six volunteers when strong winds are projected.

Figure 8 Litter pouch. Photograph by Author

While I've so far had you imagine the above-ground action, there is something very important happening at the ground level – literally. An Earth System Science graduate student attaches "litter pouches" to the floor of the shelters (Figure 8). These pouches will be collected in April, about 4 months after being placed on the floor. They will provide data to better understand the effect drought has on microbial communities' abilities to decompose organic matter. What I've described is what it takes, when all is operational, to make sure data can be drawn from these little pouches and Loma Ridge. What happens, however, when things are not working as intended?

It is believed that sometime around 6:47am on October 26, 2020, the region's powerful Santa Ana winds knocked down a power line, starting a wildfire near Loma Ridge. Fanned by the strong, dry, and hot winds, the Silverado Fire, as it came to be known, quickly grew large enough to call for the mandatory evacuation of 90,000 residents in Orange County's canyon country. Two years later, in the early fall of 2022, I joined UCI Nature field researcher Perea-Vega and a team of three undergraduate volunteers to mend the station from the damage wrought by the Silverado Fire. Before we began our work, Perea-Vega instructed us on the proper use of rattlesnake gaiters and informed us of the challenges posed by the local topography. Our first task as the mend crew: carry lengths of PVC and metal piping and boxes of equipment containing assorted nuts, bolts, ropes, and power drills to one of the fire-damaged shelters in the coastal sage scrub plots (Figure 9).

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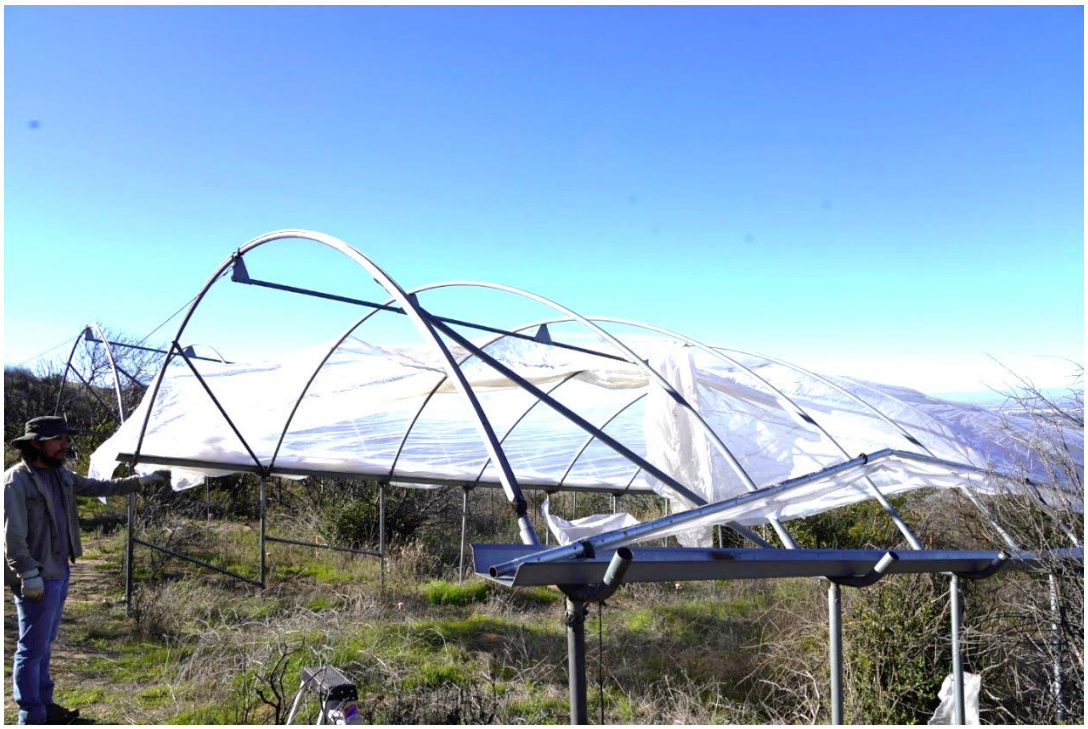

Figure 9*:* Damaged shelter. Photograph by Author

As we all gathered at the opening of the shelter around Perea-Vega, he instructed us on how to assess the fire damage, noting, "we know it is compromised and we've tinkered with it before, but the tarp continues to tear whenever there is a strong wind because some of the warping from the fire. Today, we are doing nothing short of a full repair – that's why we brought the power drills." When I asked why the repair work had not been done in the two years since the fire, he was quick to add:

> In the past, we didn't have time to fully address the issue, and COVID-19 put a pause on our volunteer recruitment. We knew that the metal pipe and PVC that holds the plastic tarp in place was compromised by the fire, but we could only replace the plastic tarp. Recently, a bit of bad luck; strong winds bent three lengths of metal pipe. Today, we are replacing the bent segments of the metal pipe, then the warped PVC, and after that we will repair the plastic tarp with large patches of adhesive tape.

Perea-Vega is clearly excited about the mending process. He quickly gets two of the volunteers to use power drills to remove the burnt PVC piping from the metal pipe. This releases the plastic tarp and makes room to remove the bent segments of metal piping. Another volunteer and I put on our gloves, grab three lengths of metal pipe, and begin our attempts at attaching them together with a power drill. "It's the first time I've used one of these," she admits. I reply that while I have expertise with leaf blowers, weedwhackers, and lawnmowers (I grew up as a residential gardener as part of my father's company and even maintained some of the neighborhoods around Loma Ridge), I too have not really handled a power drill all that often and have never used one to connect metal pipes. We lock one end of the metal pipe into the other and take turns creating the new three-segment pole.

While we worked, our counterparts removed the warped metal pipe and burnt PVC. As a group, we inserted the three new segments of metal pipe to the existing non-bent segment. Then, new PVC was attached to the metal pipe to hold the soon-to-be-mended plastic tarp in place. Perea-Vega used a small pocketknife to excise the damaged portions of the tarp and cut replacement lengths of adhesive plastic that would patch up the missing and torn segments (Figure 10). Perea-Vega notes, regarding getting the adhesive tape to bind, that "the only way to do this right is by doing the hi-five method – we are a hi-five away from drought." With Perea-Vega on a small ladder on the outside of the shelter and a volunteer standing on the inside, he applies the adhesive tape to the tarp and is met by the hand of a volunteer on the inside of the shelter; as if giving each other a hi-five through plastic (Figure 11). After three hours of intensive work, the shelter is back up and running.

Figures 10 & 11. Mending (left) and high-five (right). Photographs by Author

This day of mending has led me to wonder what it means for the LRGCE to mend itself in the context of settler land-use claims. After all, settler colonialism, like racial capital, is not natural but requires constant reproduction, or regime maintenance (Robinson, 2007), to continually reassert its claims over land (Coulthard, 2014; Kelley, 2017; Wolfe, 2016). In the case of the LRGCE, field researchers' mending work, which includes repairing, tinkering, routine maintenance, and troubleshooting, all forms of work often aligned with the raced and gendered reproductive realm (Crooks, 2019; Atanasoski & Vora, 2020; Nakamura, 2014; Vora, 2015), prevents breakdown from happening, mends what is broken, and makes the station appear to tick along as if by magic. Scholars have pointed to the often-unremarked labor behind so-called naturalized networks of technology and infrastructure (Anand, Gupta, & Appel, 2018; Hetherington, 2019; Crooks, 2017, 2019; Star, 1999) but as Atanasoski & Vora (2020) note, these systems do not exist outside the realm of human attention. There is a liberal humanist devaluation of racialized and gendered work – the work necessary for their functioning – that is forced into erasure. Labor as a liberal humanist category is not only predicated on the existence of unfreedom (slavery and indentureship, free vs. unfree) (Glenn, 2004; Lowe, 2015) but foundationally requires, as Byrd (2011) argues, the continued genocide of native societies and the extinguishing of their connections to land (p. xxv). Mending operates within the systems of (de)valuation that have historically and continually displaced native groups from their lands as the precondition to liberal humanist labor – i.e., mending takes place on stolen land to keep the LRGCE up and running. In other words, the mending of the physical apparatus of the LRGCE takes place amid the rended and torn (continually un-mended) relations with the original inhabitants and stewards of the land.

The LRGCE is a material structure that occupies Loma Ridge; it requires devalued forms of work that are labeled as so-called reproductive in nature, or as care (caring after experiments and non-human beings, microbes, and animate matter), to make sure that, from settler land-use and land grant university perspectives,

the area and science remains "productive." Mending as a theoretical armature calls into question the station's non-natural existence – its occupation of Loma Ridge – by denaturalizing the registers of activity that are devalued and necessary for its circuits of valuation under scientific regimes that produce drought knowledge. Mending makes it impossible to sidestep how the station sits on a multiply colonized settler history of land theft and ongoing land use claims by landowners and the land grant university. The previous example of drought mending, as a kind of science from below (Harding, 2008), offers an opportunity to consider the anticolonial possibilities of the LRGCE if we denaturalize the forms of activity that go into its daily reproduction. Of course, if the mending slows and drought science eventually stops, the land would still be owned privately. This doesn't mean, however, that there isn't potential, from within the political ecology of settler land-use that the LRGCE instantiates, to push for anticolonial imaginations for science and land relations in Orange County by centering, not a desire for permanence, but an acknowledgement of its occupation of native land.

5. Conclusion

As I was wrapping up the research for this article in the fall of 2022, 48,000 academic workers, which included graduate students, postdoctoral scholars, and university researchers, went on strike. Led by the United Auto Workers (UAW), they withheld labor in the form of issuing grades, running classes, and staffing experiments. The strike posed an existential threat to the University of California research ecosystem. It also posed a problem for the research efforts at the LRGCE. The strike was a reminder of just how crucial academic workers, like field researchers, are to the production of knowledge. It also brought into sharp relief the messiness beneath the surface of scientific knowledge regimes within an increasingly neoliberalized university system. Academic work *is* messy and, as the strike revealed, breakdown in the university's research production by withholding labor is a testament to workers' "living labor," as Marx termed it, that is only ever partially naturalized by forms of productivity. Unlike the constant mending that the LRGCE field researchers do for the ecosystem of knowledge production on drought, the strike during the fall of 2022 showed how student workers could forcefully break the research ecosystem of the University of California to attempt to bring about change.

The strike is a moment of disruption to a part of the regime that has undergirded colonial knowledge production (devaluation, exploitation, non-recognition of those lower down academic labor hierarchies), and one that represents notable coalition building across job categories and disciplines. It is also a moment of attempted planning for a different future – like the aforementioned workshop was – that now also faces similar challenges of "where to go from here?" That is, whether it is wage increases, or increasing public "access" in pursuit of greater "inclusion," these actions alone are not necessarily enough to fulfill goals of mending – because mending here requires ongoing efforts to repair relationships between different kinds of academic workers, and also between universities and dispossessed Indigenous communities. The example of drought mending at Loma Ridge, combined with the recent outpouring of academic worker movements organized around social and economic justice, indicates what may be required to address overtaxed ecologies of land and labor that need to be better sustained to produce knowledge needed to navigate the future of drought, and the various other problems caused by ongoing colonialism.

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