

P  
r  
i  
z  
e  
d

w  
r  
i  
t  
i  
n  
g

# ***Prized Writing***

*2022 – 2023*

Volume 34

**This anthology is produced by the University Writing Program  
of the University of California at Davis**

**© 2023The Regents of the University of California**

# Contents

Editor's Introduction..... vi

Editors Of Prized Writing..... viii

Honorable Mentions ..... xi

The Smell In Sugar Town

    Lev Gordon-Feierabend..... 1

Electronarcosis And The Porcine: The Importance Of Empathetic Animal Scientists

    Audrey Bridges..... 11

Welcome To Marshes Library: A Brief Guide For the Intrepid Travler

    Sofia De Angelis Borghesi..... 18

Conflict In 21st Century Burkina Faso: What Is To Be Done

    Joseph Brockly-Anderson..... 29

Sustainable Wildlife Tourism In Chobe National Park

    Jillian Clark..... 43

Empowering The Underprivileged: How Machine Learning Is Revolutionizing Humanitarian Assistance In Low-Income Countries

    Timothy Shen..... 56

High Nitrate In Drinking Water Across Africa And Anthropogenic Contributions

    Amber Decker..... 64



Network Analysis: Social Contagion Dynamics And Information Diffusion	
Chi Chen.....	75
East Asian American Flavors Of Home: Evolution By Adaptation	
Sofie Kanayama.....	87
Intersection Of Disability And Welfare In California: A Policy Analysis	
Manpreet Kaur.....	96
Life As An Ancestor	
Richard Pham.....	108
Sex, Power, And Glitter: The Nights I Don't Remember, The Nights I Can't Forget	
Annie Miyadi.....	116
Paving The Way For The Early Civil Rights Movement And Equality: The Fight Against Housing Discrimination In California	
Samantha Vanpelt.....	123
The Weight Of My Words	
Nkauj Hmoob Vue.....	133
From New Countertops to New Philosophies and Strategies of Design: A Woman's Place In The Kitchen	
Sophie Jorcino.....	145
Local And Cultural Importance Of The Red Abalone, A Slow-To-Recover Waning Musk	
Eden Winniford.....	156
Yurok Tribe, Et Al. V. United States Bureau Of Reclamation Analysis	
Madison Wong.....	171

<b>Reining In The West's Wild Horse Population: What Is The Debate?</b>	
Holly Eberhard.....	182
<b>Miracle Powder Or Elixir Of Death?</b>	
Jake Campo.....	191
<b>The Use Of Traditional Chinese Medicine In Cancer Treatment</b>	
Daphne Tang.....	197
<b>A Review of Algae in Space for Future Life Support Systems</b>	
Issac Yu.....	210
<b>Dengue: Fighting The Most Common Arbovirus In The World</b>	
Tan Hua.....	221
<b>Navigating The Implementation Challenges Of Supervised Consumption Sites</b>	
Dylan Rogers.....	242
<b>Pulmonary Effects Of Silver Nanoparticle Preparations By Size, Shape, And Chemical Composition</b>	
Anita Akef.....	260
<b>Spectroscopic Detection Of Huanglongbing</b>	
Grant Huez.....	283

Cover art by Lauren Thai

## Editor's Introduction

When explaining what inspired the photos featured on this year's cover, Lauren Thai said she was experimenting "with nighttime street photography in Downtown Davis and the Marina District of [her] hometown, San Francisco," to "capture the culture of the Davis community and compare it to one of the most famous cities in the world." Through this, she realized that "as it turns out— [the two] are not so different." This idea, different communities that aren't that different, seems to perfectly capture the essence of Prized Writing, and this issue in particular. Featuring an array of genres from a variety of disciplines across the UC Davis campus, Prized Writing vol. 34 is truly a community of pieces that, while different, showcase the exemplary writing that occurs across our campus community.

Coincidentally, this year allowed Prized Writing a new and exciting opportunity to engage with the UC Davis community as well. As part of the Picnic Day festivities, UC Davis held its seventh Give Day, a 29-hour fundraising event meant to bring us "together by sharing, following, or financially supporting programs that have made an impact on the lives of people everywhere." I can't express enough thanks to Lois Ann Rosenberg for a most generous initial gift, which allowed us to participate in the Give Day Challenge. I appreciate so much, too, Christine Tebes, who was immensely helpful with setting up our campaign, and the subsequent gifters who helped us reach our end goal. Sometimes being celebrated and seen by other community members is a gift in and of itself, and the support we received during Give Day definitely made us feel both.

As always, Prized Writing's success lies with the students and faculty who support it. To every instructor that encourages their students to submit work to us, mentions Prized Writing in their class, or includes Prized Writing essays in their coursework, we appreciate your support more than you know. Most importantly, we owe a huge debt of gratitude to every student that submitted a piece to us this year. Although we're only able to publish a small percentage of what's submitted, it's truly an honor to read each and every entry. To that end, I also want to thank Ted Geier, Cassie Hemstrom, Erika I-Tremblay, Sophia Jin, Ann Michaels, Greg Miller, Matt Oliver, Karma Waltonen, and Nate Williams who together served as our faculty judges for this issue.

Prized Writing continues to flourish in large part because of the support received from the University Writing Program, and in particular from John Marx (Interim Director), Carl Whithaus (Associate Director), Elliott Pollard, Anita Rodriguez, Darla Tafoya, Jasvir Mann, Kevin Bryant, Melissa Lovejoy, Vicki Higby Sweeney and Estelle Espinoza. We're fortunate to have continued institutional support from Gary May (Chancellor), Mary Croughan (Provost and Executive Vice Chancellor), Philip Kass (Vice Provost– Academic Affairs), and Estella Atekwana (Dean of the College of Letters and Sciences) as well. I'd also like to thank Bridgit Noss Patrick with ReproGraphics, Morgan Liu with the UC Davis Bookstore, and Jennifer J. Wagelie with the Jan Shrem and Maria Manetti Shrem Museum of Art for their assistance during the publication process.

Prized Writing's community would not be complete without our undergraduate editorial team. Serving as our Assistant Editor, Loudon Nidy has done a remarkable job learning the ins and outs of Prized Writing and adapting to the ever-changing duties that come with his role. Similarly, our Copy Editor, Kayla Ngai, diligently and exceptionally edited the majority of pieces featured in this volume in an effort to put forward a cohesive and reader friendly anthology.

-Jillian Azevedo, University Writing Program

# Editors of Prized Writing: 1989–2022

\* \* \* \*

Vol. 1 (1989–1990): Eric Schroeder & Kathy Dixon

Vol. 2 (1990–1991): Eric Schroeder, Marlene Clarke, & Kathy Dixon

Vol. 3 (1991–1992): Eric Schroeder, Marlene Clarke, & Kathy Dixon

Vol. 4 (1992–1993): Marlene Clarke, Kathy Dixon, Jan Probst, Sondra Reid, Eric Schroeder, James Steinke, & Jayne Walker

Vol. 5 (1993–1994): John Boe, Marlene Clarke, Kathy Dixon, Sondra Reid, & Eric Schroeder

Vol. 6 (1994–1995): Gary Goodman with Cynthia Bates, Pamela Demory, Aliko Dragona, Lara Gary, Donald Johns, James McElroy, Sondra Reid, & Jayne Walker

Vol. 7 (1995–1996): Gary Goodman with Cynthia Bates, Elizabeth Davis, Pamela Demory, Aliko Dragona, Lara Gary, Paula Harrington, Donald Johns, James McElroy, Sondra Reid, Raquel Scherr, & Jayne Walker

Vol. 8 (1996–1997): Gary Goodman with Cynthia Bates, Elizabeth Davis, Pamela Demory, Aliko Dragona, Lara Gary, Donald Johns, James McElroy, Raquel Scherr, & Jayne Walker

Vol. 9 (1997–1998): James McElroy

Vol. 10 (1998–1999): James McElroy

Vol. 11 (1999–2000): James McElroy

Vol. 12 (2000–2001): Eric Schroeder

Vol. 13 (2001–2002): Eric Schroeder

Vol. 14 (2002–2003): Eric Schroeder

Vol. 15 (2003–2004): Eric Schroeder

Vol. 16 (2004–2005): Pamela Demory

Vol. 17 (2005–2006): Pamela Demory

Vol. 18 (2006–2007): Pamela Demory

Vol. 19 (2007–2008): Pamela Demory

Vol. 20 (2008–2009): Pamela Demory

Vol. 21 (2009–2010): Pamela Demory

Vol. 22 (2010–2011): Amy Clarke

Vol. 23 (2011–2012): Karma Waltonen

Vol. 24 (2012–2013): Karma Waltonen

Vol. 25 (2013–2014): Karma Waltonen

Vol. 26 (2014–2015): Amy Clarke

Vol. 27 (2015–2016): Amy Clarke

Vol. 28 (2016–2017): Gregory Miller

Vol. 29 (2017–2018): Gregory Miller

Vol. 30 (2018–2019): Gregory Miller

Vol. 31 (2019–2020): Gregory Miller

Vol. 32 (2020–2021): Jillian Azevedo

Vol. 33 (2021–2022): Jillian Azevedo

Vol. 34 (2022–2023): Jillian Azevedo

## Honorable Mentions

Arabela Castro, "Breaking Barriers: California's Expansion of Healthcare Access to Undocumented Immigrants"

Jenevieve Weissman, "Conventional Treatment Implementation of BPal for Extensively Drug-resistant Tuberculosis"

Samuel Cervantes, "THE Climate Change Essay OR, Alternatively: How Scientists Discovered Climate Change, and Later, UsMikayla Rosario, "What a Rock Can Tell You"



# THE SMELL IN SUGAR TOWN

LEV GORDON-FEIERABEND



---

*WRITER'S COMMENT: For UWP 104, we were tasked with writing a feature-length article that could be published in a general-interest California magazine. Unsure of what to do, I got help when a family friend, knowing I was interested in environmental policy, suggested that I do a story on hydrogen sulfide emissions in Crockett, California. Through interviews and research, I was thrust into the fascinating dual worlds of waste management and air quality, with all their bureaucratic bickering, shifting blame, and corporate neglect. To help guide me through the process and offer veteran words of advice was Professor Sascha Abramksy, who connected our class to guest lectures from other world-class professionals, including the California correspondent for the New York Times. I hope readers of this piece will gain a new perspective on the everyday reality of environmental hardship endured by communities, especially in industrial areas. Environmental disaster isn't just the explosion in faraway cities like East Palestine, it's also the fires in oil refineries in Richmond, the chemicals from the foundry in Oakland, and the fumes from waste processing facilities in Crockett.*

*INSTRUCTOR'S COMMENT: Lev was a student in the fall of 2022 in one of the journalism classes that I teach in UWP. From the very first class it was clear that he was a top-notch reporter and writer, showing deep engagement with every assignment and a good intellectual grasp of what needs to be done with raw information to convert it into a gripping, informative, and entertaining narrative. Lev's reported feature article, *The Smell in Sugar Town*, was startlingly mature reporting*

*for an undergraduate. It was a thoroughly researched, ambitious, and panoramic look at a major local environmental disaster, caused by the negligence of a local company, and a desire to save money by not adequately protecting the resources upon which that company and the surrounding community depended. At every step of the way, Lev went the extra mile, interviewing far more people than was required, utilizing an array of data from a rich variety of sources, and thinking and then rethinking again how to chart a narrative most effectively. The end result, a 2,000 word feature article, was worthy of publication in any California newspaper. I am delighted that Prized Writing has recognized Lev's merits as a writer, and trust this is but the first of many articles that he writes on environmental issues over the years to come.*

*—Sasha Abramsky, University Writing Program*

If you drive east on Interstate 80 from Oakland, past the port and the sprawling Chevron oil refinery, right before you reach the Carquinez bridge, you'll see the giant smokestacks of the California and Hawaiian Sugar Company (C&H) factory. Sandwiching the plant and the water is the small town of Crockett, California. With only about 3,000 people, surrounded by the fast-growing and tech-oriented Bay Area, Crockett remains a sugar town. The cutesy, rustic browns of downtown storefronts evoke an industrial feel that is helped by the proximity to the factory, which remains an elaborate structure of pipes, storage containers, and metal railings.

However, on September 7th, 2022, the citizens of Crockett awoke to the smell of rotten eggs.

"Coming into town, as you drove down the main street, there was this odor that was just so strong," said Steve Trotter, the Public Information Officer for Carquinez Crockett Fire Department, the town's volunteer fire organization.

“It’s this putrid smell that catches you like ‘wow that’s a strong smell.’”

Residents suffered from irritated eyes, headaches, and nausea. Some, especially those most vulnerable to exposure to pollutants, experienced more pronounced symptoms. “I just had a coughing attack the night before last,” wrote one resident on Facebook, “I could barely catch my breath and started wheezing.”

The culprit turned out to be hydrogen sulfide emissions from the joint wastewater treatment facility, which processes refuse both for the town of Crockett and for its industrial neighbor, the C&H Sugar Cane factory. Community members in Crockett continued to be pummeled for more than a month by hydrogen sulfide until the area was finally deemed clear in mid-October. Running the waste treatment plant is the responsibility of C&H, which outsources to a private company. While the official line is that the record heat waves that happened on the 7th led to outages, the real story is one of deferred maintenance: shifting blame between regulatory agencies, and already overburdened communities bearing the brunt of yet another pollutant inhaled into their lungs.

## **The Reactors Go Down**

Wastewater treatment is the unsung engine of human advancement: protecting us from the parasites, respiratory infections, and cholera that can lurk in raw sewage. In the modern era, we entrust this sacred task to microscopic living organisms. Our excrement, as well as other wastewater, is funneled into reactors, where it is consumed by billions of tiny bacteria and microbes. In the case of Crockett, the bugs also have to eat up the waste from the sugar factory. The result of these creatures’ consumption is carbon dioxide, a non-toxic gas, and clean water, which can then be discharged into a nearby water source. The treated water is poured into the Bay.

If you remember high school biology, you’ll recognize the outputs of water and carbon dioxide as the products of aerobic

respiration, or respiration with oxygen. This oxygen is crucial to the reactor's process. To make sure the waste-eating creatures have the oxygen they need, the plants are aerated with blowers in every reactor, providing a steady stream of fuel for the process of aeration. Normally, explained Matthew Kaufman, the Hazardous Materials Director for Contra Costa County, the reactors look from gray to clearish color, with bunches of bubbles rising to the surface. On hot days, the amount of aeration you need to keep a similar oxygen level is increased. During record heat, like the heat wave experienced on September 7th, you need that much more.

"The high heat definitely strained our blowers," stated Josh Binder, the plant manager of nearby Pinole, which experienced similar levels of heat to Crockett, "Usually, we may just run one blower, but during the heatwave, we needed to double the number of blowers we had out for a prolonged period of time."

While Pinole and every other waste treatment facility in the area managed the record heat wave without issue, the extra demand from the blowers at the Crockett wastewater treatment facility proved too much for the plant. The Crockett plant experienced operational issues, causing its aeration to cease.

When oxygen is gone from the treatment plants, the good bacteria in the reactors that normally spew out carbon dioxide and clean water die out. They get replaced with other microbes and bacteria that can perform respiration in anaerobic conditions, or conditions without oxygen. However, this type of respiration doesn't produce the normal friendly products that aerobic respiration does. One of the main compounds resulting from anaerobic respiration is hydrogen sulfide, the chemical responsible for the rotten egg smell and health effects experienced in Crockett.

The operational issues were just the beginning of the cascading effects that led to the out-of-control situation that the Crockett plant experienced over the past month. Crockett plant employees attempted to bring in temporary aeration via new blowers, but too much damage had already been done to the health of the microbes. The plant was then forced to do a full cleanout, draining the three

reactors completely and washing the insides out with an industrial-strength cleaner called muriatic acid. As they were about to bring the plant back online, they experienced another widespread electrical failure. The blowers went down again, and the process of cleaning had to be repeated. Finally, more than a month after the plant first experienced operational issues, new bacteria was imported from the waste sludge of the Pinole treatment plant and the reactors were back up and functioning.

Amid this comedy of errors, anaerobic respiration was happening all the while, choking the community with hydrogen sulfide. Kaufman, through his position as Hazmat Director for the county, toured the dysfunctional plant. "I climbed a staircase up 25 or so feet in the air and looked down onto the three reactors," said Kaufman, "The water was not clear and gray like it was supposed to be. It was sort of this brown and murky color and there weren't a lot of bubbles coming out." "The brown sludge stuck in the reactor," he continued, "emitting an odor that permeated every corner of the factory."

## **Deferred Maintenance**

Why Crockett? While virtually every other city in California was hit with high temperatures on the weekend of September 7th, why was it that only Crockett's waste treatment facilities experienced the widespread failures that led to hydrogen sulfide being released into the atmosphere? The answer goes back to the 1970s and Richard Nixon.

The Republican President and progressive foil became an unlikely hero to the environmental movement, signing into law the Clean Air and Water Act. Suddenly, factories around the country had to monitor the pollutants that they were pouring into nearby water sources. The C&H sugar plant, which until that time was not regulated in terms of what it could and could not dump into the Bay, was forced to construct a waste treatment plant to process

its wastewater. By 1976, the C&H plant had assumed complete control of the town's waste processing.

While on paper the deal was good news for Crockett, privatizing what was once public utilities and partnering with industrial players came with its share of unintended consequences. In interviews with senior officials from Contra Costa Health Department (CCHD) and the Crockett Carquinez Fire Department (CCFD), they all agreed that deferred maintenance and difficult-to-process refuse from the plant played a large role in the hydrogen sulfide crisis. “Having toured the plant I can say that things are old,” mentioned Dr. Ori Tzivili, the Public Health Director for Contra Costa County, “The circuit board is from the ‘60s, the blowers are old, and there’s old equipment that they have never taken out.”

One peril of the privatization of normally public services is the lack of financial incentives for investment in resilience. The mandate for the Chief Executive Officer of, say, a sugar company is to make the greatest profit for their shareholders, not to provide the safest waste disposal for the community. As long as the treatment plant is working at a baseline level, so as not to incur fines, they can keep around old blowers and circuit boards. In times of extreme stress, however, issues begin to occur.

Binder, the plant manager of Pinole, claimed that while Pinole didn’t experience stresses that drove it close to losing its blowers, it’s not uncommon for treatment plants to experience failures, as Crockett did, during a heat wave. However, he stressed the importance of resilient infrastructure that allows plants to continue their vital functions. “The last treatment plant I worked at experienced lots of electrical failures,” recalled Binder, “But we were always able to keep the plant running. We were running off of power generators, diesel-powered generators at those times.”

C&H did not respond to requests for comment.

The system to keep privatization in check is regulatory government agencies. The body with principal responsibility for air emissions in Crockett is the Bay Area Air Quality Management District (BAAQMD, pronounced “back-mid” by those in on

California regulatory acronyms). They work in concert with CCHD and local first responders with the goal of ensuring that the public is safe and that emissions issues are resolved promptly. But in Crockett, when boots hit the ground, shifting responsibility, lackluster communication, and ineffective enforcement mechanisms allowed the crisis to unfold for nearly six weeks.

BAAQMD first received what would grow to be a barrage of complaints of odors (over 300 in total) immediately following the plant going down on September 7th. They began monitoring for hydrogen sulfide with handheld monitors five days later. Every complaint forced BAAQMD to go out and measure again. However, this system may have masked the true consequences. “Bay Area Air Quality Management District is primarily a complaint-driven system, so they weren’t out there taking measurements every day and they weren’t out there updating the community every day,” said Tziveli.

This raises the possibility, according to Tziveli, that residents could have been exposed to hydrogen sulfide at chronic levels or even acute levels for days before it was officially acknowledged. BAAQMD first measured hydrogen sulfide at levels past the acute warning threshold on Friday, October 7th. According to Tziveli, this was the first time that CCHD heard of the issue. They immediately issued a public health advisory.

BAAQMD disputes this timeline. According to Ralph Borrmann, a spokesperson for BAAQMD, they notified the public health department more than three weeks earlier. “On September 15th, the Air District received a complaint from a school official from the Crockett School District stating that students were experiencing some health effects due to the odors from the wastewater treatment plant,” wrote Borrmann over email. “Air District staff immediately notified the Contra Costa County Health Department and Crockett Fire Department that day.” Yet, both CCHD and CCFD deny ever having received communication from BAAQMD about student health, much less at such an early date.

This three-week delay may have been extremely costly to nearby communities. Chronic exposure to hydrogen sulfide, as defined by the Office of Environmental Health Hazard Assessment (OEHHA), the agency that sets benchmarks for pollutants, starts at a 30-day threshold. As it happened, residents were exposed to hydrogen sulfide for 30 days before a health order was issued. Had CCHD been properly notified they would have only had to wait for eight days.

BAAQMD is still in the process of conducting an investigation, the result of which they say is to ensure corrective actions have been taken to achieve compliance with regulations and ensure that a repeat of the situation doesn't happen. But few are holding their breath: "BAAQMD mostly wants to issue spare the day air alerts and prints fliers," said Claudia Polsky, a UC Berkeley Law Professor and director of the Environmental Law Clinic, who is suing BAAQMD for an unrelated incident, "They have no interest in putting boots on the ground and talking to community members who are actually affected by noxious smells and toxic air pollution."

## **Overburdened Populations**

Weeks after the air was cleared, I connected with Trotter over the phone, in the evening when he got off his day job. In his role as Public Information Officer for Crockett Fire, he spoke with the carefulness of a practiced PR professional. He was soft spoken and technical, but with the friendly gruffness of a fireman. When the effects on children were discussed, however, there was a slight yet perceptible shift in his tenor.

"We would get emails from parents saying 'my kids don't feel well', 'my kids have missed school'" said Trotter, "It was pretty clear everyone knew there was an issue, BAAQMD knew there was an issue, and we ended up talking and saying we're going have to let HazMat [the Hazardous Materials department at CCHD] know ourselves."



While HazMat can measure levels of hydrogen sulfide and compare them to OEHHA guidelines, there's little to no data on the effects of different benchmarks on human health. A few studies have shown headaches and nausea caused by exposure at the acute threshold but there hasn't been a single study on the effects of chronic exposure, which can start with much lower levels of hydrogen sulfide. This leaves the residents of Crockett wondering what impacts, if any, the odors are having on their health.

Dr. Amy Gordon, a physician in Contra Costa County, observed patients in the area have complained of breathing problems and exacerbated asthma, but she has no way of knowing if their problems are caused by the fumes.

What scientists do know is that some people experience the effects of hydrogen sulfide more strongly than others.

"We look at several populations when we're talking about vulnerability," declared Kaufmann, "The first is the very young and the very old. I think most people can relate to that and understand that. The other thing we look at is there are certain communities that we term as overburdened by pollution. Crockett is an area of concern for us."

"Even though people in Crockett may be healthy, commented Kaufmann, constant exposure to pollutants made them more susceptible to hydrogen sulfide."

Yet even with all these risks, it seems unlikely that much will change on the Crockett front. "A lot of the town," cautioned Tzivili, "is employed at the plant." Any additional upgrades that are forced on the waste treatment plant could cause the owners of C&H to decide that it's more profitable to locate their factory in an area with less strict guidelines. The tension between jobs and a safe, healthy community is typical.

"Companies do often threaten job loss, so a reduction in force on site, or threaten to move to a place with more lax regulations in the face of environmental litigation," supposed Polsky.

Ultimately, the story of Crockett is a story of two Californias. Just 30 miles away from Crockett are the high rises of San Francisco,

whose tech prowess and comfy jobs have made the median house value soar to over 1 million dollars. On the Google campus, workers ride around on hoverboards and are fed world-class meals. Yet in Crockett, and much of the East Bay, industry still drives the economy. The lack of resilience in their infrastructure, the negligence of regulatory agencies, and the burden of pollution fuel their reality.

“I can’t let my kids go for walks downtown, I can’t let my son go to school,” complained one resident in a townhall event first reported by KTVU-2. “So you can talk to us about parts per million [of hydrogen sulfide] this, part per million that, at the end of the day our town smells like shit.”

## ELECTRONARCOSIS AND THE PORCINE: THE IMPORTANCE OF EMPATHETIC ANIMAL SCIENTISTS

AUDREY BRIDGES



---

*WRITER'S COMMENT: Originally, for UWP121, I struggled with my approach to "Paper 3." That is until I found myself in the middle of a "kill room," watching the slaughter and processing of animals required for my animal science course. I grappled with the harsh reality of the experience, as it was both difficult and fascinating. It sparked a lot of creativity within me, perhaps to cope, but mostly to make sense of what I had seen. I drew, painted, and wrote. That writing eventually found its way into "Paper 3," which is the paper below. I was interested in what I had experienced – and what it meant for me to participate. Thus, I used the assignment as a way to identify myself within the science space. I had noticed a widespread stoicism in the scientific community around animal death, one I could not associate with. Therefore, one thing was clear to me: in order to continue as an animal scientist, one must keep empathy, both for their own sake and for that of the animals.*

*INSTRUCTOR'S COMMENT: It is never easy being a member of the languages-and-literature faculty and teaching the science writing classes on this campus, but I have one advantage: my sister is a UC Davis-trained veterinarian. Our animal science and pre-vet students are therefore especially welcome in my History of Science Writing class, in part because I have at least some understanding of what they are doing (the geneticists and biochemists—not so much). I was therefore pleased when Audrey proposed the present topic for one of our final assignments, in which the students tell the history of a development in a*

*science with which they have some familiarity. The final result, however, did shock me...but not too much. Our animal science students are expected to confront unpleasant realities about how animals are treated that the rest of us have the luxury of ignoring. Audrey ended up looking at those realities and reminding me of another truth: we expect the animal science students to grow up more quickly than others their age. In the sophistication of this essay, you can see the result.*

—Scott Herring, University Writing Program

A group of first-year animal science students was crammed inside the kill room. As one of the herd, I knew this was an unavoidable experience. Watching your first death is equally as life-altering as witnessing your first birth, and I had just experienced that the week prior. Despite this understanding, my lab coat felt more like a straitjacket. Looking around at my peers, I could see that many of them were stone-faced. They were already set on science, focused on anatomy and production – not the live animal walking into the room.

She was small, younger than usual. They turned on the hose, rinsing her down to ensure the electric current would pass through her entirely. She enjoyed the bath, wagging her tail and oinking – greeting the room. I lifted my trembling hands to my ears, plugging them, surprised by the cool touch of my latex gloves. I had just heard the lamb slaughter, which rang like a gunshot. The teaching assistant tapped my forearm with a polite smile.

“You don’t have to plug your ears,” she said. “It won’t be loud.”

I nodded, leaving my hands as they were. She scanned my face, probably noting the paleness and sweat. “It won’t be loud,” she repeated. I didn’t move. She nodded and left me alone.

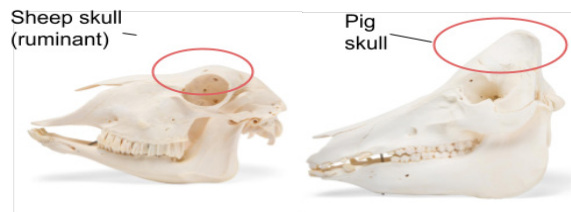
They placed the probes on the pig’s neck. She seized. It was fast. Her eyelashes fluttered, and she was beautiful. That’s something most people don’t realize about pigs. They have prominent

personalities, so intently alive, with expressive faces. I watched them cut her carotid, and her viscous blood rushed earthward – I saw them shift the body around, which was now a mere object.

*I just saw her here. Where did she go? I watched her alive, here. Just here. Seconds ago.*

I reminded myself I would have to get used to this feeling. I looked around, and many of the previously stoic faces of my peers were now streaked with tears.

As an animal science student at UC Davis, one must go through certain “rites of passage” within the major. The most notable rite is the Animal Science 002 slaughter lab. Students must participate in the live slaughter of a pig and lamb, observing the whole process – from watching the animal walk into the room, to witnessing the blood seep from the animal, and finally having to poke around in the still-warm digestive tract. Usually, when I mention the lab to non-animal science majors, they remark on the potential trauma of the experience, asking “Why would you have to watch that?” However, the young animal scientist needs to develop empathy in order to push science forward. Empathy for animals has played a surprising role in science, even historically. Specifically, in the development and implementation of the electric stunner – the most humane slaughter option for pigs – we see empathy used greatly.



**Figure 1:** Comparison of ruminant and non-ruminant skulls. Courtesy of GT Simulators.

To begin, one must understand porcine anatomy, specifically the anatomy of the head, to understand pig processing procedures. Pigs (*Sus scrofa domesticus*) have highly developed skulls, formed by the thick parietal bone. This characteristic is obvious when looking

at the top of the head (Figure 1). A morphological study conducted at the College of Veterinary Sciences and Animal Husbandry at the Central Agricultural University in Selesih, India, emphasized the anatomical values of boar skulls (*Sus scrofa*), concluding, “on its lateral surface was the deep and rough fossa crania...and the very large eminentia crania.” The lateral surface of the skull is the sides, or anywhere but the top and bottom. So not only does the pig have a thick upper skull, but the sides are thick as well, as detailed by the 2018 study.

Therefore, to slaughter a pig, one must take these anatomical circumstances into account. In most ruminants (animals like sheep and cows), captive bolt guns – blunt force trauma – are used to slaughter. However, with mature pigs, most farmers opt for electricity, or electronarcosis, due to the thick skull of the animal. The Humane Slaughter Association defines electronarcosis as just stunning by electricity, whereas electrocution means death from the shock. Both can be used in the slaughtering process, depending on the choices of the farmer. The Animal Health and Welfare Panel, an agency of the European Union, defines electronarcosis in a 2020 porcine welfare study as “the application of sufficient current through the brain to induce generalized epileptiform activity in the brain so that the animal becomes immediately unconscious and unable to feel pain.” To elaborate, when electrical stunning is used, it causes epileptic seizure-like symptoms in the animal, called a “grand mal epileptic fit.” Within this fit, the brain is overstimulated, and the body undergoes the “tonic and clonic” phases with a complete loss of consciousness.

Within the tonic phase, the animal collapses and ceases breathing – with the body becoming rigid. In the clonic phase, the body relaxes, and the animal may involuntarily move. It is important to monitor where the animal is within these phases to ensure humane slaughter. A University of Montreal study in 2009 explains that a “stunned animal shows mydriasis which retracts as the animal regains consciousness. During the pre-slaughter stun period, it is important that the pupil of the stunned animal remains

dilated until death.” The occurrence of mydriasis, or pupil dilation, is vital to verify the animal is stunned. After the clonic phase, the animal can move into a third phase – the recovery phase – where the pupils will return to normal. The animal doesn’t usually reach this phase as exsanguination (bleeding the animal out) occurs beforehand. During the clonic phase, the animal is unresponsive and unable to feel pain – this is why the farmer slaughters the animal during that time and makes sure mydriasis is still occurring when doing so.

In the past, pigs were first subjected to the poleaxe as a way to stun. As time went on, popular slaughtering methods included the captive bolt gun or simply exsanguination without stunning. However, this brought up concerns about the quality of the meat. Managing the stress of the animal prior to slaughter is vital in maintaining meat quality. Short-term stress, or stress during slaughter, creates meat with a low pH. This meat is very watery and pale, obviously not marketable to a consumer. Stunning is important to minimize pain, shortening the animal’s experience of death, and also produces a better meat product. With this understanding, the reasoning for heightened concern with animal welfare over time is more clear.

For extra insight, humane slaughter regulations and electronarcosis are only a recent development. The earliest instance of humane slaughter advocacy is with The Model Abattoir Society and its founder, Benjamin Ward Richardson. In 1922, he was defined by *The Lancet* – an independent, international weekly medical journal – as “one of the first to advocate [for] the humane killing of animals, the better hygienic structure of slaughter-houses, and cleanliness and despatch in dealing with carcasses and meat.” Richardson was a physician among many other things, including a vocal vegetarian, rallying for the humane treatment of animals. Towards the end of his career, he conducted research at the Royal Polytechnic Institution in London, England. This research focused on electronarcosis and the humane stunning of meat animals –

even though humane animal treatment was not something most people were worried about at the time.

Much later, public opinion changed, and Dwight D. Eisenhower signed a bill in 1958 due to an emotional demand by the masses. This bill, called The Humane Slaughter Act, states that “No method of slaughtering...shall be deemed to comply with the public policy of the United States unless it is humane... all animals [must be] rendered insensible to pain by a single blow or an electrical...means before being cut.” Therefore, the electric stunner was widely popularized by pig farmers to comply with these new regulations, due to the inability to use blunt force trauma on the thick skull of the pig. Interestingly, this change happened solely because the public demanded it. Empathy for animals was utilized and ultimately produced happier pigs, and thus a more quality product. Science was further advanced through emotion.

More broadly, the entire animal-slaughter industry changed because of the empathy of one scientist: Temple Grandin, now a professor teaching Animal Science at Colorado State University. Beginning her career in 1974, she developed numerous slaughter-aiding products, such as her double rail conveyor system. Grandin states that her autism gives her special insight into animal behavior. “My nervous system is more like an animal’s,” she told *The New York Times* in 1997. “The sounds that bother me are the same sounds that bother an animal.” Grandin continues by stating, “[A slaughterhouse] makes you look at your own mortality... [the animals are] so fragile inside. People are made of the same stuff.” Grandin explains her relation to animals, both emotionally and physically. But she also understands the importance of using animals for meat, explaining, “We can use animals ethically for food, but we’ve got to treat them right... We owe



Portrait of Temple Grandin. Courtesy of Rosalie Winard.

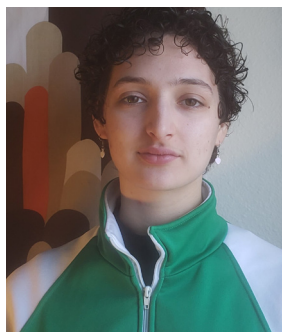


them a decent life – and a painless death.” Her empathy, tied to her technical understanding, largely impacted the animal industry through scientific change – and still does so today.

In each of these cases, emotion drove animal science forward. Whether it was the emotion of a single scientist like Richardson and Grandin, or the public as a whole, empathy enacted change. There is a facade of stoicism widely adopted by the scientific community, in which scientists remove their emotions from animal-related work. However, compassion for animals is vital in refining the slaughtering process – as we have seen historically. Experiences like the Animal Science 002 slaughter lab intervene in the development of this stoicism in the young animal scientist; allowing them to go on to develop products, or pass bills, in favor of animals. Disconnecting from empathy is counterproductive. Death in any capacity is a fact of life, and emotion is the primary facet of living. Separating the two jeopardizes scientific advancement, as empathy and humane death are intertwined.

## WELCOME TO MARSHES LIBRARY: A BRIEF GUIDE FOR THE INTREPID TRAVLER

SOFIA DE ANGELIS BORGHESI



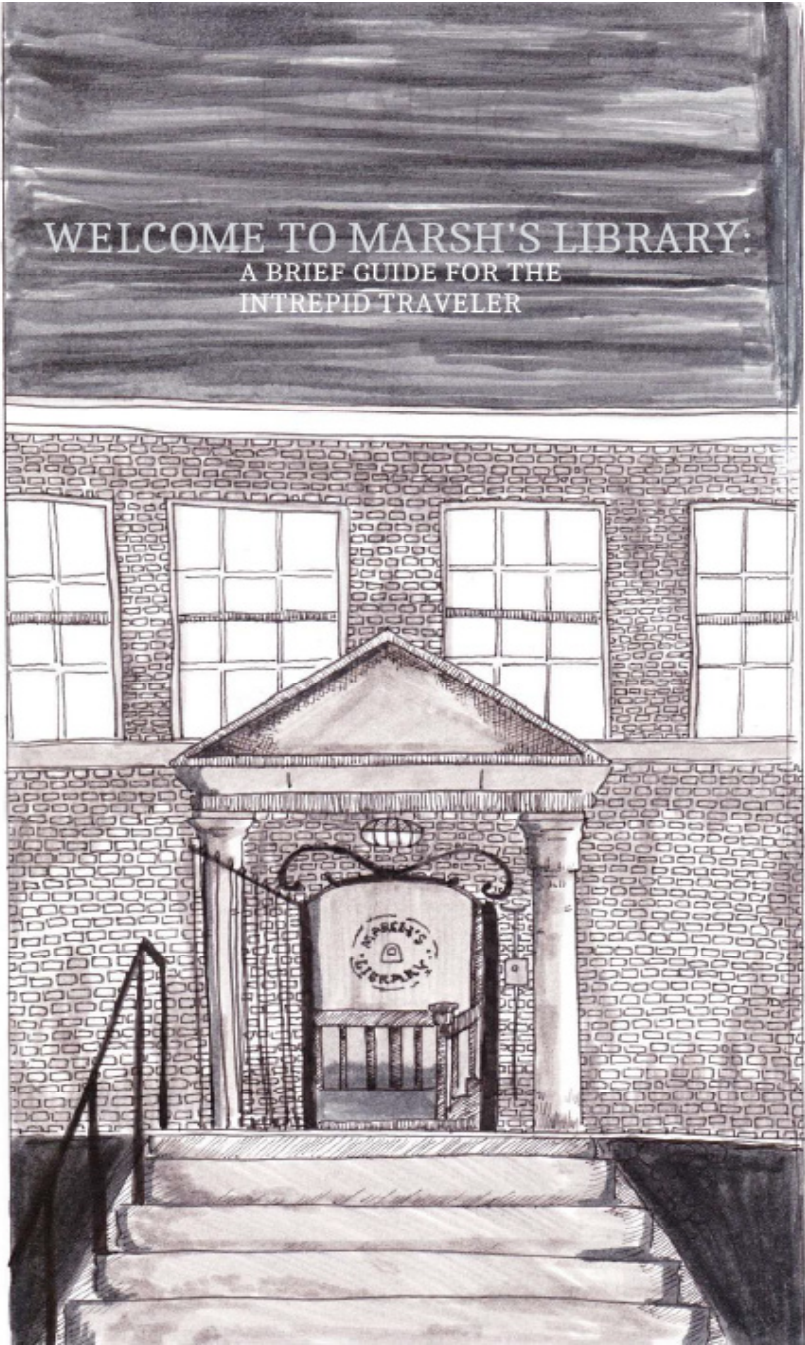
---

*WRITER'S COMMENT: If you give me the opportunity to doodle my way to a grade, I'll take it. Dr. Waltonen offered the opportunity to work with alternative media forms that quarter, should a prompt speak to us. So when we were asked to conceptualize our workplace as a country, sovereign and foreign, I jumped at the opportunity to see what art stores in Dublin had to offer. Besides excellent prices on Faber Castell pens, I found that drawing what I saw and heard everyday – the books, the people, the stories of Anglican super-divas and long-lost mummies – as defamiliarized in a world of their own was highly rewarding. Inspired by the spiel I gave visitors and the time spent taking tea in the breakroom with all the Marshians, I wanted to express the human and architectural idiosyncrasies of Marsh's Library beyond what an essay format allowed. I wanted this serious, old library to come off as a little offbeat and goofy, a place held together by bookworms (which in my time at the library, I found out were real, existing pests), retirees, and interns looking to not lose faith in their history degree.*

*INSTRUCTOR'S COMMENT: In late 2022, I had the pleasure of teaching Travel Writing and Internship Writing for The University Writing Program's Quarter Abroad in Dublin, Ireland. Students had to take a full quarter's worth of courses while also working twenty hours a week at an internship. Their final project for the Internship Writing course was to produce a document their workplace could use after we all came home to California. As in many of my UWP courses, I gave students the option to produce their papers in graphic novel format,*

*with warnings that graphic novels take much more time to create. Sofia De Angelis Borghesi embraced the challenge and created a guide for her internship. The result is as quirky, charming, and engaging as Marsh's Library is!*

*Karma Waltonen, University Writing Program*



HELLO THERE!

WELCOME TRAVELER! YOU ARE THINKING OF VISITING MARSH'S LIBRARY. IF YOU'VE OPENED THIS PAMPHLET, BUT I CAN TELL YOU MAY NOT BE ENTIRELY SOLD... HOW ABOUT WE QUICKLY TOUR THE INS-AND-OUTS OF TRAVELING TO MARSH'S? COME ON, JUST YOU N' ME, LET'S SEE...

A BRIEF HISTORY:

The sovereign bounds of Marsh's Library occupy a little less than half of all Saint Patrick's Close, and were established under the reign of Narcissus Marsh in 1707. Its Queen's passageways and highly walkable expanse has remained just as it has been in the year of its founding. The four most important men in Marshian history are depicted below, and it was their dedication to the world of books that made Marsh's a long-standing, healthy book sanctuary and nation.

Marsh's opens its borders to visitors from Tuesdays to Fridays. One important, unique aspect of tourism at Marsh's, however, is that visitors are not allowed to stay overnight. From the hours of 9:30 AM to 5:00 PM, visitors may roam the shelves and summits of Marsh's Library, but as soon as the clock strikes on that last hour... Byebye.

The Venerable Narcissus Marsh



The Venerable Edward Stillingfleet



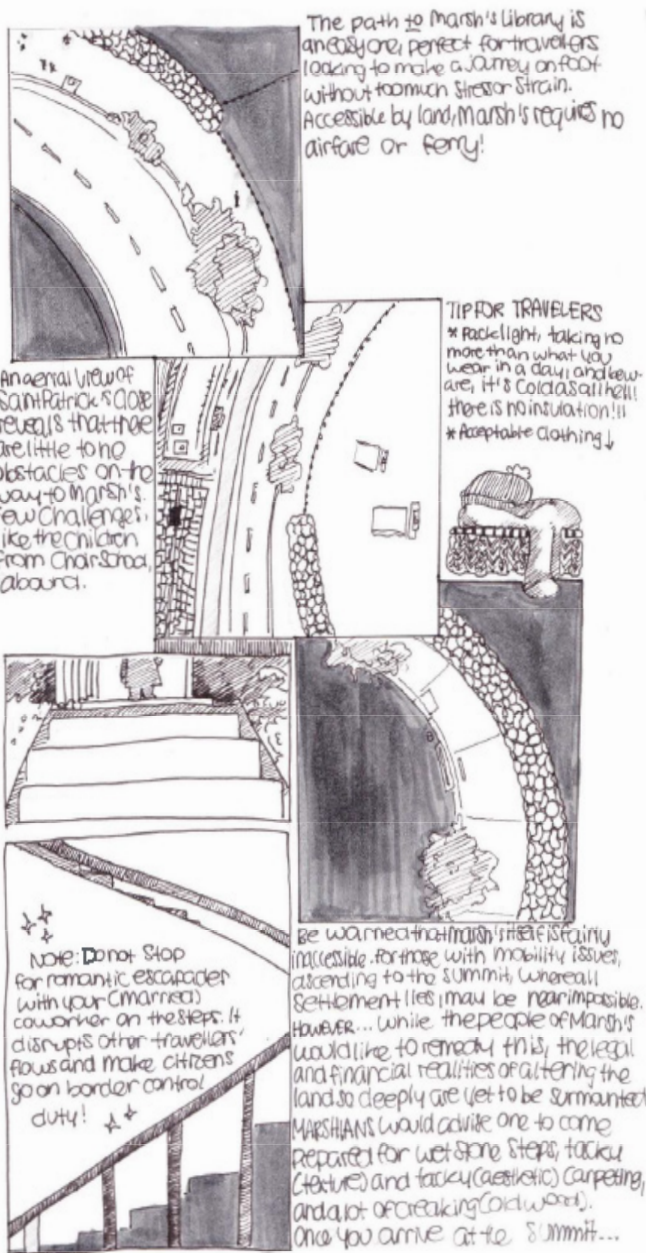
The Fastidious Elie Bouhéreau



The Irish John Stearne









A separate note to Journalists:

\* Remember that no proof and no documentation means no differential treatment! Please be courteous to our Agents at the border. Of course, residents (both citizen and non-citizen) of Saint Patrick's can move freely between the two countries. The border works on good faith. Unless of course you are a Journalist. Bring some proof.

### ARRIVING AT CUSTOMS

is a long process of fumbling cash in multi-stage ambush, and info-clumping. Upon your arrival at the Summit, you will be met by an agent at the door. Agents ask if you would like to visit, and if you are a student or an adult, as well as which language you'd prefer, and if your choice of pass-port is cash or credit. It is important to note that Marsh's provides benefits for pensioners and allows children below eighteen for free. It is worth noting that anyone traveling on academics-business also receives free entrance (sans-visa!) into Marsh's.

The official language spoken by Marshians is English. However, locals can accommodate Spanish, Portuguese, Italian, French, German, Polish, and Irish speakers! A little note on the local lingo is, however, warranted:



Visitors are immediately encouraged to engage with Marsh's most popular cultural activity should they so much notice the rego figurines hidden along the terrain. "The Rego Hunt" is an activity well loved by children and adults alike, in which one goes looking for figurines of Marsh's library's most celebrated and influential figures! Please take the damn clipboard, intrepid traveler.



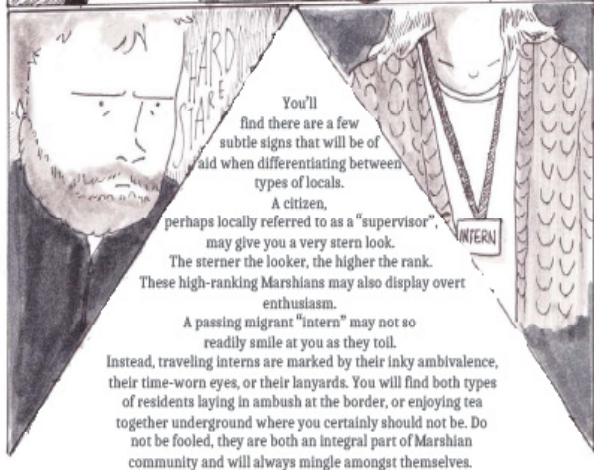
### A NOTE ON LANGUAGE

While you may speak the Queen's\* English, Marshians speak in a dialect shaped by decades of customer service and mold poisoning. You must pay attention to the cues and double-meanings in Marshian English. The question "would you like to visit?" is simply a means to herd you towards the customs desk, for example.

\*or king - the point is, they just speak different

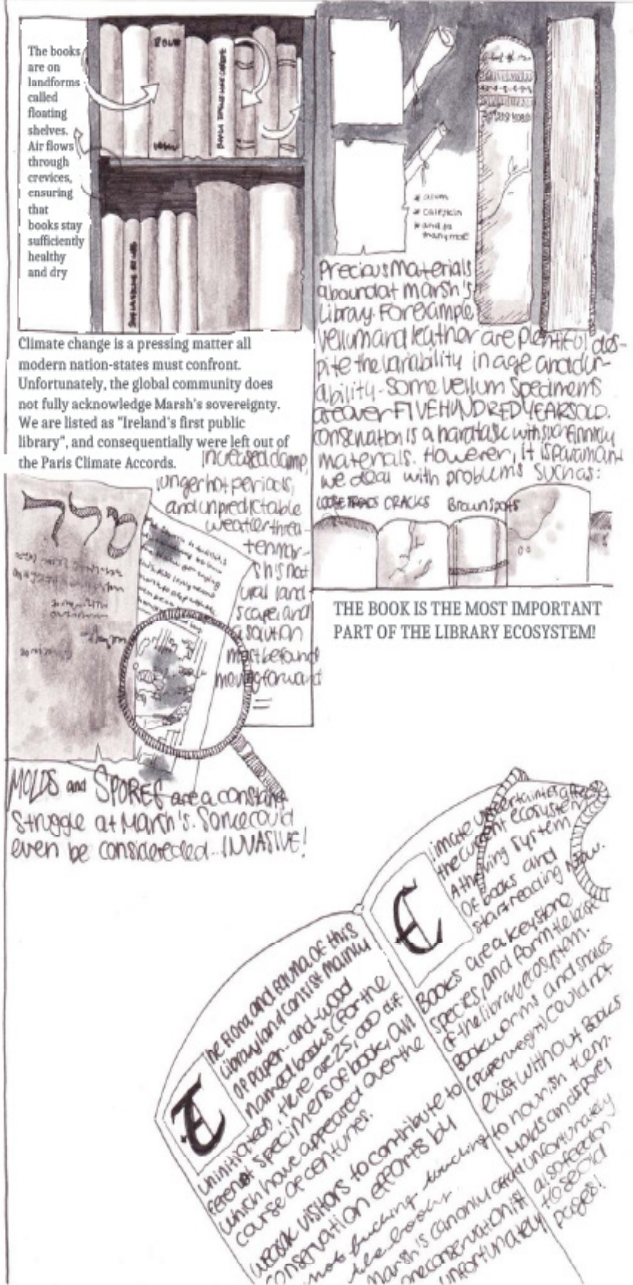


### MARSHIANS: an interesting people



CLIMATE, FLORA, AND FAUNA







### A FINAL NOTE: SAFETY and LAWS

Your safety is an important aspect of your visit. Thankfully, no one ever dies within Marsh's Library's borders... EVER.

In our long history, only one body has ever turned up, that of our friend Maurice the Mummy. We are fairly sure, however, that Maurice died well before our sovereign walls were erected... so... fear not, you are unlikely to die (here).

That being said, death is not the only unwelcome outcome you would want to avoid. Make sure you don't fall victim to ambush, battery, or any other sort of pushing around while visiting Marsh's

please mind that you must also follow the law. This includes:

- \* no flash photography
- \* no public consumption
- \* no touching local flora/fauna

STELLA THE SKULL: A LESSON IN BIGOTRY

There is no reason to be scared of the skull in the 1709 gallery. She is a resident, not a victim, and is most likely made of plaster. We believe any judgement on your part is the true crime here.


While the dead cannot hurt you, the living most certainly can. Watch out for locals eager to tell you about the bullets in the books for the thousandth time.

Beware of the cages. They are of no danger but if you jokingly ask to be locked in there one more time a local may incur bodily harm on your person with no chance of customs refund.

The crime you are most likely to be victim of is overhearing locals trash talk you.



Maurice, resident mummy



STAY SAFE, AND HOPE TO SEE YOU SOON

## CONFLICT IN 21ST CENTURY BURKINA FASO - WHAT IS TO BE DONE

JOSEPH BROCKLY-ANDERSON



---

*WRITER'S COMMENT: I've had the privilege of coming to politics from a comfortable homewith a full belly. The same cannot be said of everyone. While it's tempting to regard moral ideas as the wellspring of progress, it's important to know that some people make choices within a landscape overdetermined by forces often larger than themselves. Accordingly, moral considerations are important reflections of a more immediate material reality. I argue that understanding religious militancy in Burkina Faso and how to reduce the harm it causes requires us to look at historical momentum built up by successive generations of peoples in a dance with their environment. By telling a story about how the Burkinabè people have come to be, I treat the changing material world with primacy. To acknowledge the world as 'becoming' instead of 'being' empowers us to make mistakes and grow from experience. Famed astrophysicist Carl Sagan said it best: 'If you wish to make a pie from scratch, you must first invent the universe.'*

*INSTRUCTOR'S COMMENT: Joseph is the kind of student that every professor loves having in class: he both knows the details of every page of assigned reading, and his mind is open enough to ask big-picture questions that bring together a wide range of material. In the Contemporary African politics course where Joseph wrote this essay on the political history of Burkina Faso, he approached each session with energy, curiosity, and skepticism. His essay brings together oral history, economicsresearch based on sophisticated statistical methods, and political commentary on recent events to argue that political instability since independence in Burkina Faso must be understood*

*in the context of class conflict. Joseph is both a scholar and practitioner of politics. I have no doubt that his writing will end up making the world a more just and democratic place.*

*-Lauren Young, Department of Political Science*

For the past decade, the People of Burkina Faso have been embroiled in an intensifying conflict between their government and southeastwardly migrating Salafist militants— that have not only claimed thousands of lives but also, according to recent news reports amid a series of coups d'état, forced hundreds of thousands from their homes and millions from the country (Orosz 2022, 2; Buchanan-Clarke and Nkomo 2021, 4). Understanding the eruption, unfolding, and scale of conflict in the region requires an analysis of the historical factors that led to the development of Burkina Faso as it exists today: from “prehistoric” bands of gatherer-hunters to pre-colonial power structures, from the imposition of French colonialism to the fervor of pan-African independence, and from Marxist-Leninist revolution to neoliberal reaction, all the way to Salafist terrorism and governmental inadequacy. In overdetermining ways, all of these processes have contributed to the political, economic, and cultural structure of modern Burkina Faso and the ways in which the Burkinabè people can move forward. Because this landlocked country does not exist in a geopolitical vacuum, it is also important to explore the context of relevant historical trends from the surrounding Sahelian region and the African continent as a whole. This essay will demonstrate that the only hope of overcoming violent conflict in Burkina Faso is to critically engage with its peculiar history of class struggles in order to discover contextually pragmatic solutions that meet the needs of the local people swept into conflict.

Similar to areas across the globe, so, too, did class struggle begin long ago in Burkina Faso. To preface, Burkina Faso is a relatively small country about the size of Ecuador or New Zealand

located just south of the Sahara Desert whose recorded human habitation stretches back to the emergence of the Phoenician alphabet (Neumann and Vogelsang 1996, 177). The region has not always been so stymied by its modern struggles. Thousands of years before the area's inhabitants pledged loyalty and forced labor to the Songhai and Mossi Empires, themselves sprawling cultures that existed centuries before European colonization, they were gathering food, hunting game, raising livestock, gambling, storytelling, making pottery, and ritualistically drinking beer (Dueppen and Gallagher 2021). The quintessential qualities of the Neolithic "Revolution" —sedentary life, livestock, farming, and pottery—emerged in the Sahel, not as a package (as is assumed it did in Europe) but as a slow-rolling process undergirded by regional heterogeneity (Breunig and Neumann 2002, 123). These lively communities were traditionally governed by respected elders and local chiefs (Frechette 2021, 22, 20; Harsch 2017, 9), but as the development of the region's productive forces and division of labor progressed, material surpluses began accruing to various pillars of power that cared little for territorial acquisition. They also extended their reach over the landscape according to the intensity and variety of relationships they could foster among the People (Herbst 2000). The degree to which "archetypal stateness" may be applied to these linkages of power can be found in their capacity to extract surplus value from local laborers and engage in the military conquest of other peoples (Harsch, 9), though an increasingly terrible form of exploitation had arisen as European powers stumbled along the Gold Coast to establish trade routes and extractive markets.

In much of the same way as it unfolded across the African continent, slavery in Burkina Faso developed not only internally as a byproduct of Mossi conquests and Islamic jihads between the 16th and 18th centuries, but it was also pressured to metastasize by external forces. Up until roughly 1900, goods traders bringing precious materials into the hinterlands of the country motivated the enslavement of people that would then be trafficked Southward (through Ghana) or Westward (through Mali) to the coast, and

shipped across the Atlantic in the so-called Triangle Trade. To this day, the same researchers reflect on how the class struggle between slaves and slave drivers is reflected in the modern understanding of geographic belonging and attest to the prevalence of teasing disobedient Burkinabè children with stories of Fulbe (Peulh) slavers on horseback (Balkenhol, Blanes, and Sarró 2019, 237-239). The memorialization of slave legacies between certain ethnic groups precludes individuals from engaging in certain forms of productive economic activity to this day (Balkenhol, Blanes, and Sarró, 245; Idrissa 2019, 21). If it were not also indicated by Nunn's revelation that the material consequences of the slave trade still persist in sub-Saharan Africa (SSA) (2017), these cultural phenomena alone would be enough to unveil the historical bedrock upon which modern conflict in Burkina Faso may be founded.

The next layer of class struggle that emerges across the Sahel occurs in the lead-up to and operationalization of European conquest and specifically, in Burkina Faso's case, French colonialism. As Crawford Young and Howard W. Brown demonstrate, the operational modalities of pre-colonial regions in SSA strongly correlate to the shape in which European colonial systems would eventually come to smother them (1995). This is equally true of Burkinabè-French relations in the Scramble for Africa. Because of the unreliable accessibility of the Sahelian hinterlands, coupled with a fresh strategy of control provoked by tough lessons learned from their costly endeavor in Algeria (Young and Brown 1995, 80), the French created a colonial system based in the middle of their *Communauté Française*. It relied on traditional networks of power handed down from the Mossi Kingdoms while restructuring the underlying economic base to suit the extractive demands of the industrializing metropole (Frechette 2021, 22; Idrissa, 23). The next decade or two saw French forces slowly dominate various ethnic peoples in the surrounding countryside until the region's ultimate conquest came on the heels of suppressing the surprisingly well-organized anti-colonial holdouts of Burkina Faso's western savannah in 1916 (Harsch, 13).



By this time, the country was ruled as a part of a larger unit. It was not until the end of the First World War that France established Haute-Volta (Burkina Faso) as a separate colony. The relative environmental hardships common to the region dissuaded settlers from overrunning the area, so administration was carried out by according local chieftains the ability to execute colonial authority in new systems (inspired by the metropole) of demographic cataloging, taxation, road construction and maintenance, policing, and task routinization (Frechette, 21). They were given significant leeway to abuse their powers against the People which not only ensured their continued cooperation with the French but also established patterns of patronage that would bleed over into the era of independence (Bratton and van de Walle 1997; Harsch, 14). This indirect style of rule is largely set against the reputation of French colonialism in other regions of SSA (Young and Brown, 108). Nevertheless, the neolithic flows of capital and coercion that had given rise to pre-colonial kingdoms and their colonial conquerors all had direct consequences for Burkina Faso during the era of independence and beyond.

This period of decolonization was somewhat of a farce. Despite an atmosphere of exuberance, promise, and pan-African solidarity, traditional, intellectual, and political elites all jockeyed for privileged positions atop colonially-inherited state structures (Christensen and Laitin 2019, 14). The great mass of people remained unorganized and yearning for an end to the irrationality and chaos “born of a white man’s world.” J. F. Ade Ajayi (1982, 5) puts it in eloquent detail: “Their notion of freedom was not an abstract ideal, but a catalogue of specific wants...” (1982, 5). As is wont to happen when the spirit of liberation meets the grindstone of class struggle, “These wants developed and became more specific with each new hope and each disastrous frustration” (Ajayi 1982, 5).

In a foreshadowing of the independence era, the first man to take the lead had just a year before ordered police to harass pro-independence partisans (Harsch, 20). The first twenty years saw

frequent abuses of power lead to successive coups d'état, military juntas, and constitutional referendums headed by what Micheal Bratton and Nicholas van de Walle would label neo-patrimonial rulers (Engels 2019, 113). Many Burkinabè believed that France, hungover from its colonial intoxication, involved itself in these coups through financial and military reimbursements (Harsch 2014, 49). There was a brief period in the 1980s that would see a dramatic transformation of governance in the region, only to be "rectified" in the type of cyclical power alteration exemplified by the coup-insurgency trap described in Roessler that was afflicting the majority of SSA at the time (2011). This revolutionary period, itself born of a coup d'état, saw sweeping changes to the lived material conditions facing the average Burkinabè in a way that would profoundly alter the country's expectations of the future and orientation to the challenges of modern Salafist extremism.

The story of Burkina Faso's modern conflict begins to appear ever more salient in this era as Blaise Compaoré tortures and assassinates in cold blood the country's prior revolutionary leader, his ex-comrade, Thomas Sankara in a bid to gain power. The revolution that sought to end this back-and-forth motion of political upheaval between factionalized representatives bestowed upon the country its modern name Burkina Faso, translated from a local language as the "Land of Incorruptible People." The revolutionary government sought to make this demonym (a portmanteau between the country's three dominant language groups to symbolize national unity) a material reality by trying coup leaders and military generals from former regimes in public tribunals, depressing the privileges and salaries of state functionaries relative to the agricultural-pastoral majority, and extending the justice-making capacity of the state to the perpetually marginalized and rural poor. The considerable lack of development, market penetration, and investment in Burkina Faso relative to other former French colonies put this period of accomplishments into context (Harsch 2013, 360). The tangible changes made to civil and political life therein helped solidify the Burkinabès' quest for

a democratic government to this day. Despite varying degrees of success, not a single state structure was unaltered, but as Ernest Harsch concludes, “the failure to even question the military’s place within the state was seriously short-sighted” (2014, 67) and would lead to the neoliberal reaction that followed.

The justification for a new coup came as a way to “rectify” some of the abuses of authority that came from administrative organs set up during the 1980s. Blaise Compaoré, second in command, became a natural pole around which oppositional forces produced by intragovernmental factionalism could mobilize. A precipitous decline in Western military backing coincided with the balkanization of the USSR along with the adoption of Structural Adjustment Programs loaned out from the IMF led to a period of turbulent democratic mobilization across much of SSA. This forced the Compaoré regime in the Burkinabè context to adopt the scaffolding of a multiparty electoral system in return for shackling the country with debt (Harsch 2014, 115; Idrissa, 18). This did little to change the underlying structure of political representation. Compaoré’s willingness to accept the IMF’s debt conditionality without a significant vision of his own incurred various problems related to increasing unemployment, stagnant wages, currency devaluation, dramatic spikes in maternal mortality, and privatized corruption (Engels, 113).

Following this “wave of democratization” that swept across Africa in the 1990s, a rift emerged between economically advancing, politically reforming countries and those stymied by a struggle to industrialize, institutional inefficiencies, and peripheral insurgencies (Christensen and Laitin, 9; Ochieng’ Opalo 2012). Modern Burkina Faso sits among these latter countries and in 2014, upon hearing of Compaoré’s intention to remain President by manipulating the Constitution, the Burkinabè people had had enough.

The ensuing coup d’état and general insurrection that engulfed civil society did not occur in a geopolitical vacuum. Elsewhere across West Africa, a threat to Burkina Faso was brewing that

Leonid M. Issaev, Andrey V. Korotayev, and Daria A. Bobarykina suggest was temporarily mitigated by the authoritarian intelligence apparatus of the Compaoré regime (2022, 418). Following the Arab Spring in 2011, countries in the Sahel region have been increasingly drawn into international conflicts with violent Salafist militants connected with Al-Qaeda (AQ) and the Islamic State (IS). One of these groups and its affiliates—Jama’u Nusrat ul-Islam wa al-Muslimin’ (JNIM)—represent the most immediate source of widespread instability afflicting Burkina Faso, but A. Idrissa acknowledges the existence of four separate conflicts: war between France and the Salafist militants, that of the Salafist militants on the Burkinabè state, interethnic conflicts spear-headed by the Fulani, and lower-level skirmishes between farmers and herders in the East (13). Each of these conflicts has definitive roots in the development of class struggles connected to every historical period discussed herein. How this can be understood requires further elaboration.

The geological ecology and neolithic development of Burkina Faso led to broad groups of economic activity. In the Southwestern savannah, it was possible to establish agriculture and sedentism, while pastoral herding proved suitable in the Northeast, both of which led to the development of communities with diverging interests (Idrissa, 9). The economic power of ethnic groupings—notably, the northern Fulani—that are nowadays in conflict with others via their elites’ pursuit of maintaining fading privileges—sprang up during the days of capturing and trading enslaved people. Colonialism and the resurgence of extractivist markets during neoliberal “rectification” helped exacerbate long-standing bifurcations in development and power-sharing between Burkina Faso’s shrubland and savannah which seems to heavily correlate with the proliferation of Salafist insurgencies in the Northeast. Finally, these conflicts all contribute to the gravity of one another in a way that has internationally entangled the governments of Niger, Togo, Côte d’Ivoire, and Ghana—all led by French security forces. Idrissa structures an analysis of the key players as follows: state and international actors include the Burkinabè government,

Salafist militants as colluding with French globalists, and Salafist militants, criminal networks, bandits, and unaffiliated opportunists (13). seen within the context of French (Western) understandings of regional security as terrorists whose essence needs eradication (Idrissa, 13). These views are often held despite the ambiguity among these groups.

This traditional understanding of counterterrorism has proffered several alternative explanations to account for the dramatic spike in militant insurgency in Burkina Faso since the fall of Compaoré's regime. Accordingly, the weakness of the state to provide strong security forces and its internal exhaustion in the face of struggles over the former colonial apparatus have contributed to an intensification of terrorist activity. These activities made inroads into northern Burkina Faso as Malian rebels supplied with weapons that made their way from Gaddafi fighters, following the collapse of the Libyan status quo, and joined forces with Salafist insurgents in the wake of Compaoré (Atta 2022, 6). They have merged into new, more powerful formations with the capacity and motivation to carry out attacks on state police, military, and tourist operations (Issaev, Korotayev, and Bobarykina, 413). The Burkinabè state has likewise had a difficult time in dealing with these groups because of the ways that slavery and colonialism have kept the region from developing. The problem of class struggle is indeed global in scope when one considers the transcontinental multilayered networks of drug trafficking that these groups provide protection for in return for their financing (Atta 2022, 7).

The motivations given for these attacks are numerous. The heavy-handed response from French military forces (and those led by them) garnered significant backlash and counterproductively contributed to the growth of Islamic militancy by making it feasible for more people to claim victimhood status. The religious garb these groups wear may seem straightforward, but as Stephen Buchanan-Clarke and Sibusiso Nkompoint out, expansion through Burkina Faso, including certain groups' (Ansarul Islam, for example) desire to reestablish the economic power of the 118th century

Caliphate of Hamdullahi and other long-gone kingdoms (Crone 2017, 33; Afriyie 2019, 7), provides access to incredible economic opportunities via the control of port access, piracy, and illicit trade. The economic marginalization of communities in the North is a strong over determinant in the area's protection of militant groups who promise them a new future under religious clothing and this region is precisely where UCDP indicates the majority of casualties in the country. This becomes highly salient when considering the historical implications of neolithic transformation, slave trading, colonialism, independence, revolution, and neoliberalism in creating and entrenching these material, class-based divisions in Burkinabé society.

Why have traditional counterterrorism methods failed to deal with these conflicts in Burkina Faso and West Africa more broadly? Operating within a newly emerging field of critical study, Atta provides us with some clues that begin with how terrorism is framed in discourse. The now-hegemonic Western conceptualization of terrorism fails to consider it as a socially constructed phenomenon, that states may be terroristic by their own definitions, or that terrorism may not be bound by moral essentialism in a battle of good versus evil but rather understood as a tactic in a broader constellation of strategies by which political actors attempt to meet their needs or desires. Michael J. Gilligan, Eric N. Mvukiyehe, and Cyrus Samii suggest direct financial payments to ex-combatants, like those that exist in programs across SSA, are not contributing to the political reintegration of militants (2012, 620). However, Allison N. Grossman, William G. Nomikos, and Niloufer A. Siddiqui conclude that peaceful ideals alone do little to end violent intolerance (2021, 10). In short, a counterterrorism approach that fails to critique the methods of terrorism from within a context in which these groups and their victims emerge is bound to reproduce contradictions that prolong its ineffectiveness. Considering the indigenous challenges and local conditions of Burkina Faso, without recourse to paternalistic counterterrorism blueprints imported from the region's former

colonizers, is a master key for finding long-term solutions to the various interlocking class conflicts heating up in the country.

To drive home the conclusion that Burkina Faso and its state and civil society, Salafist insurgency rocking the country, and methods used to deal with all of these “problems” evolve out of the forceful nature of class conflict, it is appropriate here to draw in two poignant observations: Parenti and Clausewitz’s. Parenti states, “The close relationship between politics and economics is neither neutral nor coincidental. Large governments evolve through history in order to protect large accumulations of property and wealth” (Parenti 1974, 4) and Clausewitz’s central thesis that war is politics by other means (Clausewitz 1918). These blend together to highlight that war and terrorism are means to economic ends. The kingdoms that developed on the backs of divided “neolithic” laborers gave way to the slave trades that enriched Burkina Faso’s eventual French colonizers who sullied the country’s natural ability to develop their industry and economy. This underdevelopment has consistently led to problems of access to basic needs, which helps drive people into the hands of those promising to fulfill them. The class struggles of Burkina Faso have changed their forms and content, but still, they remain and are responsible for everything related to its modern conflict.

## Bibliography

- Afriyie, Frederick Appiah. "Burkina Faso: An Inquisition of Ansaroul Islam Insurgency in West Africa and Its Emerging Threat." *Conflict Studies Quarterly* 29 (2019).
- Ajayi, J. F. Ade. "Expectations of Independence." *Daedalus* 111, no. 2 (1982): 1-9.
- Atta, Francis Kwabena. "Understanding Africa's terrorism debacle: a critical analysis of counterterrorism in Burkina Faso." *Critical Studies on Terrorism* (2022): 1-19.
- Balkenhol, Markus, Ruy Llera Blanes, and Ramon Sarró, eds. *Atlantic perspectives: places, spirits and heritage*. Berghahn Books (2019).
- Bratton, Michael, and Nicholas Van de Walle. "Neopatrimonial Rule in Africa." *Democratic experiments in Africa: Regime transitions in comparative perspective*. Cambridge University Press (1997): 61-82.
- Breunig, Peter, and Katharina Neumann. "From hunters and gatherers to food producers: New archaeological and archaeobotanical evidence from the West African Sahel." In *Droughts, food and culture* (2002): 123-155.
- Buchanan-Clarke, Stephen, and Sibusiso Nkomo. "Violent Extremism in Africa: Citizen Perspectives from the Sahel Epicenter and Periphery." (2021).
- Carl von Clausewitz. "What is War?" *On War* 1, trans. Col. J.J. Graham. New and Revised edition with Introduction and Notes by Col. F.N. Maude, in Three Volumes. London: Kegan Paul, Trench, Trubner & C. (1918).
- Christensen, Darin, and David D. Laitin. "African States Since Independence: Order, Development, & Democracy." *Yale University Press* (2019).
- Crone, Mannie. "The Rise of Jihadi Militancy in Burkina Faso." *Expanding Jihad: How Al-Qaeda and Islamic State Find New Battlefields* (2017): 23-33.
- Dueppen, Stephen A., and Daphne Gallagher. "Alcohol, ancestors, and the house: Exploring ritual use of beer at Kirikongo, Burkina Faso." *Journal of Anthropological Archaeology* 64 (2021).
- Engels, Bettina. "A stolen revolution: popular class mobilisation in Burkina Faso." *Labor History* 60, no. 2 (2019): 110-125.



- Frechette, Izabela. "Post-Conflict Recovery or Conflict Recurrence: A Comparative Analysis of Economics, Colonial Histories, and Natural Resource Mining in Burkina Faso and Togo." University of Massachusetts Amherst (2021).
- Gilligan, Michael J., Eric N. Mvukiyehe, and Cyrus Samii. "Reintegrating Rebels into Civilian Life: Quasi-Experimental Evidence from Burundi." *Journal of Conflict Resolution* 57, no. 4 (2012): 598-626. DOI: 10.1177/0022002712448908.
- Grossman, Allison N., William G. Nomikos, and Niloufer A. Siddiqui. "Can Appeals for Peace Promote Tolerance and Mitigate Support for Extremism? Evidence from an Experiment with Adolescents in Burkina Faso." *Journal of Experimental Political Science* (2021): 1-13.
- Harsch, Ernest. *Burkina Faso: a history of power, protest, and revolution*. Bloomsbury Publishing (2017).
- Harsch, Ernest. "The legacies of Thomas Sankara: a revolutionary experience in retrospect." *Review of African Political Economy* 40, no. 137 (2013): 358-374.
- Harsch, Ernest. *Thomas Sankara: An African Revolutionary*. Ohio University Press (2014).
- Herbst, Jeffrey. "Power and Space in Precolonial Africa." *States and Power in Africa: Comparative Lessons in Authority and Control* 149. Princeton University Press (2014): 35-57.
- Idrissa Abdoulaye, A. "Tinder to the fire: Burkina Faso in the conflict zone." *RLS research papers on peace and conflict studies in West and Central Africa* (2019).
- Issaev, Leonid M., Andrey V. Korotayev, and Daria A. Bobarykina. "The Global Terrorist Threat in the Sahel and the Origins of Terrorism in Burkina Faso." *Vestnik RUDN. International Relations* 22, no. 2 (2022): 411-421.
- Neumann, Katharina, and Ralf Vogelsang. "Paléoenvironnement et préhistoire au Sahel du Burkina Faso." *Berichte des Sonderforschungsbereichs* 268, no. 7 (1996): 177-186.
- Nunn, Nathan. "Shackled to the Past: The Causes and Consequences of Africa's Slave Trade." (2010).
- Ochieng' Opalo, Kennedy. "African elections: Two divergent trends." *Journal of Democracy* 23, no. 3 (2012): 80-93.

- Orosz, Adele. "Violent extremism in the Sahel is strengthening its grip in West Africa." *Africa at LSE* (2022).
- Parenti, Michael. "Partisan Politics." *Democracy for the Few*. Cengage Learning (1974): 1-4.
- Roessler, Phillip. "The Enemy Within: Personal Rule, Coups, and Civil War in Africa." *World Politics* 63, no. 2 (2011): 300-346. DOI: 10.1017/S0043887111000049
- Young, Crawford, and W. Howard Brown. "The African colonial state in comparative perspective." *History: Reviews of New Books* 24, no. 1 (1995): 39-40.

## SUSTAINABLE WILDLIFE TOURISM IN CHOBE NATIONAL PARK

JILLIAN CLARK



---

*WRITER'S COMMENT: During the pandemic, I watched a documentary about how the absence of human activity in many locations was proving to be beneficial for the environment and animals. Because of this, I became interested in how the tourism industry negatively impacts the planet; when Dr. Bender asked the class to write a white paper on an environmental issue, I was eager to further research this topic. I choose to focus on wildlife safaris in the African country called Botswana. Known for its lush scenery and dense animal populations, Botswana has become a tourist hotspot. While at face value, safaris seem like an enriching way to connect with exotic animals, in reality, they are driving animals away to unsuitable habitats and ultimately are causing population numbers to drop. In my paper, I evaluate the impact that wildlife safaris and the tourism industry as a whole have on animals and I propose potential solutions, like building water-holes. I hope that my piece helps bring awareness to the issues surrounding wildlife safaris and encourages readers to choose sustainable tourism.*

*INSTRUCTOR'S COMMENT: At the start of my Environmental Writing course (UWP 102G), we dive right into identifying environmental problems that the students want to research and write about. Jillian Clark knew immediately that she wanted to write about the impact of tourism on the environment, specifically wildlife, and she soon settled on Botswana's Chobe National Park as the site of her inquiry. As readers will learn in Jillian's white paper, the current threats to wildlife in Chobe result from earlier interventions intended to protect*

*the animals from hunting safaris while simultaneously sustaining the local economy. Thus, proposing a solution isn't as simple as shutting down tourism in the park. Jillian's white paper offers a realistic and multifaceted approach to the problem—one that is based on a thorough research into the effects tourism has on park wildlife as well as a nuanced understanding of the needs of various stakeholders.*

*- Melissa Bender, University Writing Program*

## **I. Abstract**

In the African country of Botswana, Chobe National Park faces immense environmental damages due to its increasing popularity as a tourist destination. The economy of Botswana is largely reliant on the revenue from tourism but a misuse of natural resources and lack of environmental awareness threatens the industry as a whole. Animal populations are decreasing due to human disturbances and habitat destruction as land is cleared to build tourist lodges. Pollution, congestion, and the overuse of safari vehicles has caused natural surroundings to look less appealing to visitors. A recent decongestion strategy introduced by the Department of Wildlife and National Parks has limited safaris to three hours to reduce environmental disturbances and tourist density. However, the time allotted is not enough to see wildlife in areas other than the Chobe Riverfront, causing more congestion in this location. To achieve sustainable tourism, the pressure must be taken off this tourist hotspot by diverting visitors to other areas of the park. National Park authorities need to adjust and enforce policies to encourage tourists to add other destinations to their agendas. Additionally, artificial waterholes can be used to attract wildlife to new locations, distributing tourists more evenly across the park and allowing the overused locations recovery time.

## **II. Impacts On Wildlife**

After Botswana banned hunting safaris due to decreasing wildlife populations, photographic tourism was marketed as a sustainable alternative and Chobe National Park quickly became a popular destination (Moswete et al., 2017). This reserve is known for being the home to a wide variety of animals, particularly elephants (Mosikare, 2022). Despite this effort to help wildlife, animal populations are still declining in Chobe National Park largely due to human interference. For instance, the constant use of vehicles for safari purposes causes an excessive amount of noise that drives wildlife away to inadequate habitats. Speedboats along the Chobe River disturb aquatic life with noisy engines while loud safari aircrafts stress and scare away many birds and land mammals; the government has taken no action to combat these issues (Moswete et al., 2003). Excessive noise also interferes with the sleeping and mating patterns of animals such as big cats and hippopotamuses, resulting in death or disappearance (Moswete et al., 2017). Animals such as these sleep during the day and forage or hunt at night (“Wild Facts Sabi Sabi Private Game Reserve: How the Big Ones Sleep”, 2014) so disrupting their patterns leads to starvation.

Human-borne diseases are another threat to wildlife (Mogende and Moswete, 2019) along with pollution. Fumes from boat engines pollute waters, suffocating fish and making waterfronts less attractive (Mogende and Moswete, 2019). Littering harms wildlife as well through choking or strangulation. Additionally, the introduction of domestic species like dogs and donkeys combined with litter ruins the natural aesthetic of the surroundings that tourists are paying to see (Mbaiwa, 2005).

Apart from noise and pollution, wildlife is also threatened by habitat degradation. The introduction of exotic weeds has dismantled river systems and discouraged the growth of natural vegetation (Moswete and Mavondo, 2003). Forests are being cleared out to make way for new hotels inside the park, not only

taking away wildlife habitats but also restricting animal movements, especially that of elephants (Mosikare, 2022). Plus, the everyday use of safari vehicles has created muddy, slippery tracks that have caused sands to erode (Mogende and Moswete, 2019).

III. Economic Concerns

Botswana’s economy is largely dependent on the revenue generated by the growing tourism industry (see Figure 1). The income brought by visitors has allowed the economy to shift away from its reliance on diamonds and has provided over 23,000 jobs (Kajevu, 2008). By providing employment opportunities for locals of Botswana, the tourism industry has encouraged village infrastructure and education (Mbaiwa, 2005). Additionally, tourism has caused a decline in poaching since this industry is much more profitable for locals (Moswete and Mavondo, 2003).

However, these economic benefits are minimized due to enclave tourism, which involves foreigners taking over large sectors of the

Table 1: Number of visitors to Chobe National Park in the period between 2009 and 2015

Chobe National Park	2009	2010	2011	2012	2013	2014	2015
Private visitors	18,089	25,373	25,577	29,227	32,462	36,563	34,854
Mobile tour operator clients	47,277	49,408	53,438	63,179	78,257	90,515	78,128
Inside fixed camps/lodge clients	18,559	14,655	17,885	18,934	19,570	20,298	18,303
Outside fixed camps/lodge clients	86,982	96,975	96,900	100,195	111,361	118,763	104,547
Non-fee-paying tourists	13,770	10,480	11,091	2,132	1,788	1,135	1,803
Total	184,677	196,891	204,891	213,667	243,438	267,274	237,635

Source: Department of Wildlife and National Parks (DWNP, 2015)

Figure 1. The number of tourists to Chobe National Park has exponentially increased between the years 2009 and 2015 (Mogende and Moswete, 2019).

industry (Mbaiwa, 2005). This results in a substantial amount of the profit to leak out of Botswana (Moswete and Mavondo, 2003), taking business away from locals and hurting Botswana’s economy.

Enclave tourism is even more problematic as foreigners frequently disregard the rules of Chobe National Park that were put in place to protect the land.

#### **IV. Stakeholders**

Sustainable wildlife tourism has a variety of stakeholders. Primary stakeholders include the Botswana government as well as local employees since they are financially dependent on the success of tourism. As animal numbers drop and the natural reserves become less desirable to visit due to physical appearances, tourists numbers themselves are likely to drop, negatively impacting the economy of Botswana and causing an increase in unemployment rates.

Like the government and locals, private tourism businesses and companies also are reliant on high attendances of tourists. These include lodging and hotel businesses, souvenir shops, booking agencies, and guided safari tours. Tourism business owner are directly involved in the sustainability of tourism since they are responsible for deciding where in the park new buildings are placed and they play a role in determining the capacity for guests in certain locations. Businesses need to be encouraged to expand to different, less crowded areas to help with guest flow in Chobe National Park (see Figure 2). Additionally, business owners could put money towards building artificial waterholes in these new locations, attracting wildlife which in turn draws tourists.

Lastly, tourists themselves are stakeholders since the push for more sustainable tourism would create a more appealing environment. High congestion of tourists along areas of Chobe National Park reduces the visibility of animals, resulting in dissatisfaction of guests (Mogende and Moswete, 2019). Promoting education regarding sustainability to tourists would benefit the park while allowing the tourists to have a more enjoyable experience.



Figure 2. A map of Chobe National Park showing the high density of lodges along the Chobe Riverfront (“Botswana Safari and tour Packages”).

## V. National Park Policies

In an attempt to reduce environmental devastation caused by the tourism industry, park officials have already put some policies into effect. The Chobe National Park “code of conduct” allows only four vehicles to be present at an animal sighting and only for a duration of five minutes (Mogende and Moswete, 2019). The Department of Wildlife and National Parks has enacted a similar decongestion strategy that limits safari tours to only three hours (Moswete et al., 2017).

However, these recent mandates are ineffective and are causing further damage to the park. This is partly due to the fact that foreign business operators frequently disregard the rules (Moswete and Mavondo), but also because the shortened safari time has increased the amount of visitors to the Chobe Riverfront. Not enough time is allotted for driving to locations that are further away, such as the park’s upper routes or Nogatshaa (Moswete et al., 2017). The



Chobe Riverfront has a higher concentration of wildlife due to the fact that many animals are water-dependent, so tourists choose this destination to ensure that they can see the animals they are paying to view.

In order to resolve this issue, park officials need to offer longer safaris, taking into account the driving time needed to get to destinations that are further away from the loading point. By doing so, locations such as the upper routes or Nogatshaa would be more appealing since the drive itself would no longer take up most of the animal-viewing time. Park officials could also limit the amount of safaris that are allowed to go to the Riverfront; however, they would need to enforce this rule for it to be effective. To further incentivize tourists to book destinations other than the Riverfront, park officials need to invest in methods to attract animals to these locations.

## **VI. Artificial Waterholes As A Solution**

One such method for attracting wildlife to different areas of the park is using artificial waterholes. Essentially a man-made body of water, artificial waterholes have already been constructed in arid regions of South Africa such as Kruger National Park. Even though natural water was available, the distribution of wildlife changed in the park (Smit et al., 2007). More than 26 species were attracted to these waterholes, including African elephants, impalas (an antelope species) and white artificial waterholes are especially successful in attracting wildlife during dry seasons, reducing the concentration of animals near natural rivers and pools (Smit et al., 2007). Since drought is a common occurrence in Botswana with an annual rainfall of 340 mm (Mogotsi et al., 2013), these waterholes would help to conserve and manage the natural water for later seasons; wildlife would benefit from additional water sources in the park during droughts.

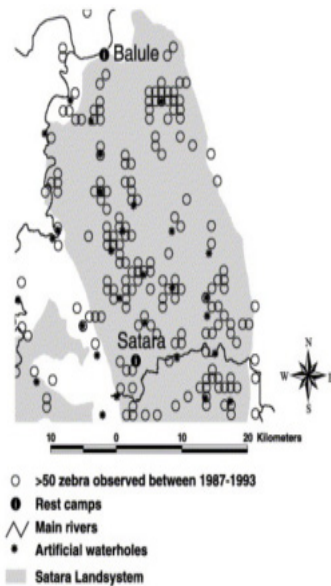


Figure 3. A map of Kruger National Park depicting rhinoceros (Sutherland et. al., 2018) concentrations of zebras around artificial waterholes Although artificial waterholes primarily (Smit et al., 2007). attract herbivores (see Figure 3), predators like large cats follow their prey, providing tourists with a variety of animals to view.

While adding artificial waterholes is still a form of human intervention and has both positive and negative environmental impacts, overall there are more benefits than consequences. One major concern of adding waterholes is the impact they have on vegetation (Smit et al., 2007). Since primarily herbivores are attracted by waterholes, natural vegetation that was previously left untouched is now being grazed. To resolve this issue, African areas that have artificial waterholes practice a common management strategy which involves periodically closing off certain waterholes so that the vegetation can regrow (Smit et al., 2007). If this strategy was adopted by Chobe National Park, overused areas could be given time to regenerate. The change of wildlife distribution in the park is reflected by guest flow since tourists go where they can see the most animals, so by opening and closing different waterholes, park officials could control where visitors

spend their time; the addition of artificial waterholes would greatly reduce congestion in the park.

## VII. Alternatives to Wildlife Tourism

Although tourism in Botswana largely consists of wildlife destinations like Chobe National Park, the country has much more to offer. Attraction operators could take some of the pressure off these natural hotspots by encouraging visitors to see other sites

and locations as well. These could include national monuments, historical sites, museums, or attending cultural events, all of which would help to extend the socio-cultural benefits of tourism (Mbaiwa, 2005).

Tourism in Botswana is critical not only for economical reasons but also because it helps to preserve cultural traditions. Local communities set up tourist camps where visitors can be introduced to traditional food, dance, and music (Mbaiwa, 2005). Tourists can also buy handmade souvenirs which supports the community. Many of the locals that organize the tourist camps are elderly (Mbaiwa, 2005), so tourism provides them with an opportunity to share their culture and traditions that they otherwise would not have. Visiting these locations also helps to combat the issue of enclave tourism since the tourists' money is going directly to local communities rather than a foreign business enterprise.

By park officials advertising these destinations for visitors to add to their agendas, tourists would be more dispersed throughout Botswana, spending less time at Chobe National Park and giving the reserve some time to recover. Wildlife and tourists alike would benefit; animals would face less disturbances and tourists would likely be more satisfied with their trip if Chobe National Park was less congested and better matched their expectations.

## **VIII. Conclusion**

Each year, exponentially more tourists visit Chobe National Park to see its diversity of wildlife and the natural landscape. While tourists may be under the impression that wildlife safaris are an environmentally-friendly way to enjoy nature, in reality, the high concentration of visitors in certain areas of the park are causing harmful impacts, especially along the Chobe Riverfront. Pollution, litter, and noise are causing animals to leave or die while the physical environment deteriorates from the constant wear-and-tear. Since the country of Botswana is economically dependent on tourism and thousands of locals are employed by this industry, they

must find a way to make tourism more sustainable to ensure that they can rely on it in the future.

Despite the efforts of park officials and the Department of Wildlife and National Parks, major improvements still must be made. The current mandates that attempt to protect the environment are ineffective because they fail to address the root of the problem, which is that there is not enough incentive for tourists to visit new locations instead of the Riverfront. In order to create better guest flow in the park, park officials and managers need to find a way to draw in visitors to different locations.

Although it may seem counterintuitive to the issue, if park officials allowed safari times to be longer than the current three hours allowed, then tourists may be more willing to take a longer drive to different locations. One of the reasons that the Riverfront is so popular and congested is because it is close to the loading point, meaning a short drive with lots of animal-viewing time. Accounting for the driving time would mean that no wildlife-viewing time gets lost. Tourists could also visit locations in Botswana outside of Chobe National Park in order to support and learn about the culture. Doing so would reduce the amount of time spent in the park which would help with congestion. Additionally, park officials should invest in building waterholes throughout Chobe National Park, attracting animals to new locations and thus better dispersing tourists throughout the area. Proper management of waterholes would consist of alternating between open and closed ones in order to minimize anthropogenic impacts and best benefit the environment and wildlife. To protect the future of the industry and the environment, action must be taken to make tourism more sustainable in the present.

## **References**

- “Botswana Safari and Tour Packages”. Botswana Safari  
Tours and Luxury Trips - Botswana Safari Lodges. Retrieved  
February 15, 2023 from  
<https://www.botswana.co.za/>.
- Kajevu, Z. (2008). Botswana: Tourism - Ranking worries BNPC.  
AllAfrica. Retrieved February 15, 2023 from [https://allafrica.com/  
stories/200804080555.html](https://allafrica.com/stories/200804080555.html)
- Mbaiwa, J. E. (2005). The socio-cultural impacts of tourism  
development in the Okavango Delta, Botswana. *Journal of Tourism  
and Cultural Change*, 2(3), 163-185.  
<https://doi.org/10.1080/14766820508668662>
- Mogende, E., & Moswete, N. (2019). Stakeholder perceptions on  
the environmental impacts of wildlife-based tourism at the Chobe  
National Park River Front, Botswana. *PULA: Botswana Journal of  
African Studies*, 32(1). Retrieved January 19, 2023 from  
<https://journals.ub.bw/index.php/pula/article/view/1526>

Mosikare, O. (2022). Anger as Botswana govt plans luxury hotels inside Chobe National Park. NewsAfrica. Retrieved January 27, 2023, from <https://www.newsafrika.net/267>

Moswete, N., & Mavondo, F. T. (2003). Problems facing the tourism industry of Botswana. Botswana Notes and Records, 35(1), 69–78. Retrieved January 19, 2023 from [https://journals.co.za/doi/abs/10.10520/AJA052550590\\_132](https://journals.co.za/doi/abs/10.10520/AJA052550590_132)

Moswete, N., Nkape, K., & Tseme, M. (2017). Wildlife tourism safaris, vehicle decongestion routes and impact mitigation at Chobe National Park, Botswana. SpringerLink. Retrieved January 27, 2023, from [https://link.springer.com/chapter/10.1007/978-3-319-55574-4\\_6](https://link.springer.com/chapter/10.1007/978-3-319-55574-4_6)

Mpolokang, M. O., Perkins, J. S., Saarinen, J., & Moswete, N. N. (2022). Environmental Change, Wildlife-Based Tourism and Sustainability in Chobe National Park, Botswana. Southern African Perspectives on Sustainable Tourism Management, 169–185. [https://doi.org/10.1007/978-3-030-99435-8\\_12](https://doi.org/10.1007/978-3-030-99435-8_12)

Smit, I. P., Grant, C. C., & Devereux, B. J. (2007). Do artificial waterholes influence the way herbivores use the landscape? Herbivore distribution patterns around rivers and artificial surface water sources in a large African savanna park. *Biological Conservation*, 136(1), 85-99. <https://doi.org/10.1016/j.biocon.2006.11.009>

Sutherland, K., Ndlovu, M., Perez-Rodriguez, A. (2018) Use of Artificial Waterholes by Animals in the Southern Region of the Kruger National Park, South Africa. *African Journal of Wildlife Research*, 48(2), 1-14. <https://doi.org/10.3957/056.048.023003>

“Wild Facts Sabi Sabi Private Game Reserve: How the Big Ones Sleep.” (2014) Sabi Sabi. Retrieved February 15, 2023 from

[https://www.sabisabi.com/discover/wild-facts/how-the-big-ones-sleep#:~:text=Hippos%2C%20 with%20the%20sun-%20 Sensitive,takes%20place%20during%20the%20day.](https://www.sabisabi.com/discover/wild-facts/how-the-big-ones-sleep#:~:text=Hippos%2C%20with%20the%20sun-%20Sensitive,takes%20place%20during%20the%20day.)

## EMPOWERING THE UNDERPRIVILEGED: HOW MACHINE LEARNING IS REVOLUTIONIZING HUMANITARIAN ASSISTANCE IN LOW- INCOME COUNTRIES

TIMOTHY SHEN



---

*WRITER'S COMMENT: For the final writing assignment in UWP 104E, we were tasked to write an article catered to the general audience about interesting developments in our respective fields of research. As a statistics major, I was immediately drawn toward the emerging topic of machine learning. Currently, machine learning is commonly associated in headlines with consumer innovations like social media algorithms, chatbots, self-driving cars, etc. However, a simple glimpse into academic papers shined a vastly different story. It brought to light machine learning's immense promise in far more critical areas such as healthcare, poverty, and climate change. For the first time, I finally understood the hype and craze for machine learning that every tech fanatic passionately declares. The more vital and critical purpose of machine learning was hidden away under the intimidating technical overload of academic journals. These realizations compelled me to highlight research showcasing the potential of machine learning in addressing socio-economic issues. Specifically, this paper explores a recent innovation in machine learning and its potentially pivotal role in alleviating humanitarian crises in third-world countries.*

*INSTRUCTOR'S COMMENT: When Timothy proposed writing a literature review about novel methods of applying machine learning to mobile phone data, to better estimate socioeconomic demographics of low-income countries and thus inform humanitarian aid, I was excited for him. He had already described (in the NSF Graduate Research Fellowship personal statement for an earlier assignment) his love for demystifying statistical analysis and supporting scientific research*



*across disciplines. As he described it, during an internship with the Open Medicine Foundation Chronic Fatigue Syndrome (CFS) Data Center at the Stanford Genome Center, he realized that he could help advanced scientists in adjacent fields. They represented their data in different ways from one another, and were sometimes intimidated by the center's unfriendly data analytics software, and might thus have been missing key insights into one another's research data. His project there clearly empowered them by helping them share their data and more easily, and better understand statistical methods. In "Empowering the Underprivileged," Timothy drew on his developing expertise as a double major in math and statistics, and thoroughly researched and shared novel applications of machine learning methods. He employed rhetorical moves throughout the literature review to convey the importance of the topic, synthesize the research he found, and urgently point the way towards future research. Timothy's strong writing and research here convey his deep ethical sense, advanced quantitative skills and a deep desire to support collaborative science and progressive policy. His is one of the strongest literature reviews I've seen in UWP 104E: Writing in Science.*

*—Marit MacArthur, University Writing Program*

**A**bdullahi was her favorite grandson, Sontoy Mursal reflected. For all their life, they resided in a farming area in southern Somalia. In the past four years, rainfall has consistently fallen short of sustaining crop growth, forcing the small village to rely on outside goods. But it was different this year. The militant group, Al-Shabab, has taken over the region cutting off the movement of goods. As a result, Sontoy and her family must, every couple of months, embark on a 60-mile expedition by donkey cart to the city of Baidoa for food—a two-week journey.

Sontoy and her family are not alone. In the past year, 7 million people in Somalia—nearly half of the population—are deprived of urgent assistance for malnutrition, an issue well aware

of the government. However, aid responses have been difficult and delayed. Al-Shabab has controlled southern and central Somalia, restricting the reach of humanitarian aid. Thus, the government lacked the ability to identify where assistance is needed the most. <sup>[3]</sup> They also cannot turn to government data to target the most impoverished as much of it is outdated. <sup>[2]</sup> In the case of Somalia, it has been almost 46 years since the last government census.

In fact, with limited data, Somalia could not officially declare a famine as it had no idea of the severity. <sup>[3]</sup> Without this declaration, global funding and assistance for the famine stalled as no one knew where to target their aid. <sup>[2]</sup> It took almost an entire year when finally a plan is in place to provide aid over the next rainy season as crops are expected to falter again. But for Sontoy and her family, it will be too late. Abdullahi died of starvation during one of the treks, forcing Sontoy to bury him on the side of a road—he was just six years old. <sup>[3]</sup>

Large-scale targeted humanitarian assistance programs, especially in times of crisis, have long been plagued by the absence of immediate data. Even in the United States, a high-income country, the lack of available household data forced COVID-19 economic relief programs to rely on self-reported income leading to over \$80 billion being given to fraudsters in 2021. <sup>[4]</sup> But for low-income countries, a disaster like this could lead to further permanent economic damage and—for families like Sontoy—lives. So, what's the solution?

It is evident that there is an essential need for up-to-date data to meet the demand for urgent humanitarian assistance. But repeatedly conducting censuses every year is extremely expensive and time-consuming for low-income countries. Additionally, for politically ravaged countries like Somalia, it's nearly impossible to conduct. Hence, the solution has turned to an alternative way to collect up-to-date statistics on these countries.

Mobile phone data usage has increased significantly in low-income countries over the past years. Mobile phone data or Call Detail Records (CDR) commonly can feature a user's call location,

the call duration, the time of the call, and the user's data plan. With these features, CDR data can provide up-to-the-minute insight into a user's behavior. In fact, according to recent research at UC Berkeley, wealthy people use phones differently from the impoverished. Whom they call, where they text, which data plan they use, and when they call can all follow different patterns among different sociodemographic backgrounds.<sup>[2]</sup> Consequently, researchers, like Dr. Aiken a professor at UC Berkeley, have turned to the incorporation of pattern recognition tools—like machine learning—to identify these patterns.

Machine learning (ML) algorithms can be trained from past data to recognize and make inferences from emerging trends. A popular ML algorithm, the gradient-boosting model makes predictions or decisions on a set of input features. The model works by combining a large number of simpler models, called decision trees, in a way to improve its accuracy. A decision tree is like a flowchart that helps you make a prediction based on certain features. Take this as a simple example: imagine you are trying to predict the price of a house based on features like size, location, and number of bedrooms. If the house is located in a wealthy neighborhood, has more than 4 bedrooms, and is larger than 2000 square feet, the decision tree might predict a higher price given past data on houses with similar features. However, a single decision tree may not provide enough accuracy.

This is where gradient boosting comes in. Using many decision trees—each making its own prediction, gradient-boosting combines them until the model reaches a set desired accuracy. For instance, if multiple decision trees signify that wealthy neighborhoods always lead to higher prices, then the model will add more weight to that feature in predicting expensive housing. The model essentially learns from its mistakes and adjusts to improve its accuracy. A powerful and efficient technique that can offer a way to predict sociodemographic statistics.

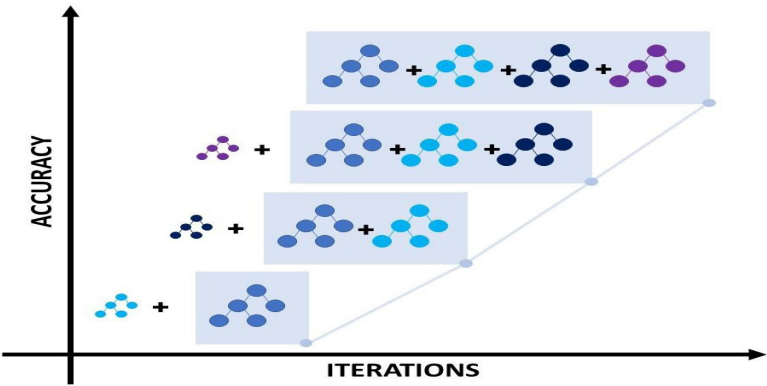


Figure 1: At each iteration, the gradient-boosting model combines a decision tree, improving its accuracy.

Dr. Aiken tested the viability of gradient-boosting in estimating poverty in Afghanistan along with its CDR. Like Somalia, Afghanistan’s Targeting the Ultra-Poor (TUP) program has long been hindered by incomplete data on identifying poor households. Currently, the TUP program uses traditional estimation models from asset index and consumption data to recognize the ultra-poor. Due to the out-of-date nature of these sources, the process to collect data and train the models takes at least half a year.<sup>[1]</sup> However, CDR presents a readily accessible solution as it takes just hours to receive it. Furthermore, CDR allows the use of already gathered traditional data to supplement the model—improving its accuracy. Thus, along with a gradient-boosting model, CDR leads to a process that takes just a couple of weeks.

Poverty Estimation Models in Afghanistan

	Accuracy	Time Until Completion
CDR	69	~1-3 weeks
Asset Index	72	~6-9 months
Consumption	69	>1 year

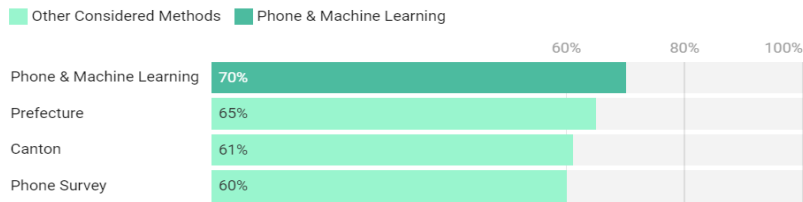
Adapted from Aiken et. al (2020)

**Figure 2:** CDR-Based Model and Traditional Models Accuracy Rate<sup>(1)</sup> and Speed. Created from DataWrapper

The CDR-based gradient-boosting model successfully measured poverty in Afghanistan. The model, 69% of the time, could accurately differentiate a citizen who was impoverished from one who was not. The model was nearly as accurate as the best current TUP estimations method, however, took just weeks to build—a significant result.<sup>[1]</sup> Thus, CDR and a gradient-boosting model provide an approach to targeting humanitarian aid in low-income countries that can meet the urgency of a crisis. But what does it look like in action?

With the peak of the COVID-19 pandemic in 2020, Togo’s government turned to this machine learning approach in implementing its cash aid program. Dr. Blumenstock from the School of Information at UC Berkeley partnered with Dr. Aiken in adapting a gradient-boosting model for Togo’s economic condition. Similar to Somalia, Togo’s last conducted census was over a decade ago. Thus, the researchers conducted a two-week-long phone survey in September 2020 to collect information on the living conditions of 15,000 households. Then, the researchers trained the gradient-boosting model, along with existing CDR, to recognize characteristics of people living on less than \$1.25 per day—the threshold for cash aid. Togo’s model accurately predicted the target threshold 70% of the time. Subsequently, in November, less than two months after the start of the research, the cash assistance

Accuracy of Considered Methods by the Togo Government



Adapted from Aiken et. al (2022)

**Figure 3:** Accuracy of Considered Methods by the Togo Government<sup>[2]</sup>  
Created from DataWrapper

program was rolled out. The method was significantly faster and more accurate than any other modeling methods considered by Togo’s government. Currently, the program has provided nearly \$10 million to around 137,000 of the country’s poorest citizens. <sup>[2]</sup>

The use of mobile phone data and machine learning in providing estimates for targeted humanitarian aid programs in low-income countries has the potential to revolutionize aid delivery. Therefore, as the trends of machine learning and phones continue to grow, there must be a rising awareness of the potential impact it can make on empowering impoverished communities. By leveraging mobile phone data and machine learning, governments and aid organizations can better understand the needs of the populations at a much more rapid rate. All of this allows aid programs to prepare and respond more efficiently—potentially saving many lives and preventing tragedies like Sontoy’s family.

## Reference

- [1] Aiken, E. L., Bedoya, G., Blumenstock, J. E., & Coville, A. (2020). Program targeting with machine learning and mobile phone data: Evidence from an anti-poverty intervention in Afghanistan. *Journal of Development Economics*, 161, 103016. <https://doi.org/10.1016/j.jdeveco.2022.103016>
- [2] Aiken, E., Bellue, S., Karlan, D., Udry, C., & Blumenstock, J. E. (2022). Machine learning and phone data can improve targeting of humanitarian aid. *Nature*, 603(7903), 864–870. <https://doi.org/10.1038/s41586-022-04484-9>
- [3] Jerving, S. (2022, September 6). 'The Cavalry Hasn't Arrived:' Somalia on the Brink of Famine. 'The cavalry hasn't arrived:' Somalia on the brink of famine. Retrieved March 15, 2023, from <https://devex.shorthandstories.com/the-cavalry-hasn-t-arrived-somalia-on-the-brink-of-famine-brink-of-famine/index.html>
- [4] Office of Comptroller General of the United States. (2023). Emergency Relief Funds (GAO Publication No. 23-106556). U.S. Government Accountability Office. <https://www.gao.gov/assets/gao-23-106556.pdf>

## HIGH NITRATE IN DRINKING WATER ACROSS AFRICA AND ANTHROPOGENIC CONTRIBUTIONS

AMBER DEKKER



---

*WRITER'S COMMENT: Here is one thing you will hear when you travel to most areas in Africa: do not drink the tap water. This diverse continent, abundant in natural resources, still experiences the effects of exploitation, making it hard for many areas to secure reliable access to fundamental necessities, including safe drinking water. I used the UWP 104E literature review assignment as an opportunity to explore the scientific topics I was learning about in my environmental engineering classes, and to shed light on the disproportionate challenges faced by less privileged regions of the globe. This topic is one close to my heart, since I have family from Ethiopia. I have also been studying with Dr. Eliot Atekwana, and will soon travel to Cameroon to assist with his isotopic geochemistry. The impending threat of climate change will worsen the effects of elevated nitrate levels and other contaminants in drinking water, and I hope to one day use what I have learned in my academic journey to help communities in need gain access to these resources we so often take for granted.*

*Instructor's Comment: People who teach at a university are never entirely happy with their classes. Some part of the syllabus is always a bother—but there is also some part of every course that is always just right. In my writing in the professions: science class, the part that is just right is an assignment, the literature review. Two things about it work: first, the students write about a topic they know well and care about, and second, they craft that topic so that it is the very first literature review ever written on this exact subject. The two requirements go together: when the student knows the material well, it is*



*possible to be original, and when the literature review is original, it makes connections no one has ever made before. amber's winning entry combines several subjects that she has mastered: repeatedly during the quarter, she wrote on water and other environmental issues, displaying a wide range of expertise, and she knows africa well, too. the result is a highly professional piece of work.*

*- Scott Herring, University Writing Program*

## **Abstract**

Stable access to clean drinking water is not the reality for the millions of people living in rural and semi-urban areas in Africa. Studies across the continent show high levels of nitrate (NO<sub>3</sub><sup>-</sup>) in groundwater and other drinking water sources. These high readings are mainly due to unregulated anthropogenic sources, such as increased agriculture and unsanitary wastewater treatment methods. However, many rural areas do not have the economic means to invest in water sanitation infrastructure, as the continent has 9% of global renewable water resources to support 15% of the global population. Climate change also contributes to this issue, as intensified droughts decrease access to sanitary drinking water. This review compiles studies from across Africa analyzing the high nitrate levels, anthropogenic and climate change contributions, and water quality and sanitation methods for groundwater and drinking water.

## **Introduction**

The United Nations Sustainable Development Goals (SDGs) were established in 2015 to serve as a blueprint to improve equity along with environmental and human health around the world. Many of these goals relate to clean water, but access to safe drinking

water is often challenging and threatened in rural and developing countries, especially for areas in Africa. In sub-Saharan Africa, for instance, a quarter of the population does not have access to safe drinking water, as high population growth and urbanization over the years were not accompanied by economic growth and investment in water and sanitation infrastructure. Many populations depend on water from shallow wells, boreholes, and other water sources that are constantly threatened by contamination, especially from an abundance of nitrate ( $\text{NO}_3^-$ ) (Armah et al. 2018).

Groundwater is a common source of drinking water in many parts of Africa due to its reliability; it also has the advantage that it is cleaned by natural filtration processes. People in the countryside rely on it despite its vulnerability to fluctuating and intense weather conditions. Nitrogen can get into this water through geological and anthropogenic routes, such as through fertilizers and improper disposal of waste and manure (Anornu et al. 2017). The World Health Organization (WHO) has set recommended limits of 10-11 mg/L  $\text{NO}_3^-$ -N (or 45 mg/L  $\text{NO}_3^-$ ) for drinking water, but studies have shown that drinking water sources across Africa greatly surpass these limits, leading to health problems among both the people and the ecology (WHO 2016). A high intake of  $\text{NO}_3^-$  (a possible carcinogen) is often linked to “blue baby syndrome” among infants and can lead to other serious health implications. A study conducted by Toure et al. (2019) in a commune near Segou, Mali showed that the drinking water contained nitrate levels ranging from 11.05 to 23.40 mg/L (above recommended WHO levels). A health survey found episodes of diarrhea, typhoid fever, gastroenteritis, and amoebic dysentery in 55-61%, 38-52%, 43-54%, and 31-39% of responders, respectively. Additionally, health issues such as vomiting, kidney problems, general fatigue, nausea, skin lesions, and cancer were found in residents who consumed the water.

The sources of nitrate can be discovered through hydrochemical and isotopic analysis. At a river basin in Ghana, samples showed  $\text{NO}_3^-$  levels of 0.42-431.17 mg/L in boreholes, 0.83-143.9

mg/L in hand-dug wells, and 0.03-28.94 mg/L in surface water. The  $\delta^{15}\text{N-NO}_3$  and  $\delta^{18}\text{O-NO}_3$  isotope data confirmed that the  $\text{NO}_3$  in the samples came primarily from manure and denitrification (Anornu et al. 2017). A study in Ethiopia also showed that the use of pesticides in agriculture contributed to nitrate levels in Lake Ziway that exceeded WHO standards by over 7% (Teklu et al. 2018). This trend of high nitrate levels in drinking water is found throughout the continent and is most prevalent in rural and semi-urban areas that lack the means or infrastructure to effectively treat the water before it is used and consumed by residents.

## **Water Contamination Factors**

### **Anthropogenic Activities**

Anthropogenic activities contribute greatly to nitrate contamination in surface and groundwater. A study conducted in South-East China by Liu et al. (2019) showed that the three main anthropogenic drivers for nitrate contamination in the study area were urbanization, agriculture intensification, and population density, and these findings clearly apply elsewhere in the developing world. Africa greatly depends on its agriculture to feed their growing population and for economic purposes. This has caused populations to use more groundwater and chemical fertilizers, contributing to increased concentrations of nitrate and less available groundwater. A study in Ghana by Ahialey et al. (2010) showed that with the dramatic increase in population, the increased water demand, necessity of agricultural activities, and unregulated disposal of sewage has contributed to a drastic increase in groundwater nitrate levels over the past few decades. During this period, the population of Africa had continued to increase, reaching 639 million in 1990 and almost 1.47 billion in 2023.

The common use of pit latrines due to the lack of access to more sanitary waste methods also contributes to nitrate contamination in drinking water across the continent. An analysis of the groundwater quality in Ramotswa, Botswana revealed that

the nitrate pollution is likely caused by human waste leaching from the pit latrines and, drawn down by gravity, infiltrating the groundwater beneath (McGill et al. 2019). Furthermore, these pit latrines are often not well maintained, allowing the waste to make its way into unconfined aquifers through the saturated groundwater zone. In this way, the hazardous compound in the sewage often gets into drinking water. Not only can this lead to the spread of waterborne diseases, but organic minerals in human and animal waste contain large amounts of nitrogen, which can change into different nitrate forms through the nitrogen cycle. The chemical compounds react with their environments to produce nitrogen in different forms, including  $\text{NO}_3^-$ , as nitrate is a more stable form of oxidized nitrogen (Denk et al. 2017).

## **Water Treatment**

There is limited access to sufficient water treatment methods in rural areas across Africa, and limited enforcement of sanitary methods. Most communities lack a centralized water supply system, and therefore each residence uses the treatment method they have access to and can afford. Many current treatment methods across Africa are not effective at removing harmful pathogens, and further treatment is therefore necessary (Barrie et al. 2021). Many areas do not have the means to use westernized treatment methods, and there are few regulations on wastewater disposal and treatment. Enforcement of regulations is also spotty. A study in 2021 by Barrie et al. evaluated three common wastewater treatment methods for drinking water in Southern Sierra Leone at Njala University and the neighboring Mokonde communities, testing for *E. coli* bacteria (from fecal matter) after the treatment. All three methods, namely first flush diversion, perceived natural treatment, and the conventional method, failed to completely eradicate the bacteria found in the water, violating the recommended WHO guidelines. Further treatment is often necessary to render the water potable.

## **Climate Change**

As temperatures increase and droughts become more intense due to climate change, more water is evaporated from reservoirs, reducing even further the levels of available drinking water for people in rural areas across the continent. As the water levels decrease, the concentration of nitrate and other chemicals in the water will increase due to salinization processes. McGill et al. (2019) conducted a study analyzing the connections between climate change, sanitation, and groundwater quality in Ramotswa, Botswana, showing that the increasing nitrate levels were mainly due to anthropogenic sources, such as pit latrines and caffeine, and became intensified by extreme drought conditions. Poor groundwater quantity greatly affects the groundwater quality, especially as the annual population growth rate of 3.9% continues to increase the strain on the supply of drinking water. This is the reality for many areas across Africa, as a higher population increases both the demand for water and the volume of human waste, while climate change inevitably increases the intensity of droughts and limits the available drinking water.

The same study argued that water and sanitation infrastructure must be optimized in order to protect groundwater quality (McGill et al., 2019). With decreasing water availability, flush toilets will be harder to supply, increasing the use of pit latrines. These latrines must be lined in order to prevent waste from seeping into the groundwater and contributing to nitrate contamination. Rainwater could also be captured and stored for plumbing purposes, but these infrastructure improvements require expensive installation and equipment that residents can not afford (McGill et al., 2019). One possible solution is the use of an at-home filtration system with plant xylem. This easily available plant system involves forcing water down the xylem, as the small pores filter the water and catch pathogens and other contaminants before the water is consumed. A study by Ibrahim et al. (2022) showed that a filtration device using pine xylem (the most effective xylem plant) effectively removed

100% of the E. coli in the tested water, over 70% of present metals, but only about 5% of the  $\text{NO}_3^-$ . Further treatment was required in order to remove the inorganic ions in the water. This device also requires a long waiting period as water becomes filtered, so although it is effective in removing most contaminants, it is not the long-term solution needed by families across rural Africa.

## **Conclusion**

Rapid urbanization and increasing populations across the continent of Africa makes it ever more urgent that we find techniques of effective management of water supply and sanitation, in order to mitigate the high nitrate and organic pollutant levels in the widely-used groundwater. However, efficient treatment methods are not readily available, especially in rural and semi-urban areas, as water treatment infrastructure and management are very expensive. As many countries can not afford to invest in such infrastructure, water quality will continue to worsen, especially with the impending threat of climate change and intensified weather conditions. As the United Nations places a strong emphasis on fair access to clean water, they should follow through with their SDGs and help countries across Africa and other developing areas with drinking water treatment, as families and children are continually suffering from unsanitary drinking water. This should be the highest priority, as everyone deserves access to safe and accessible drinking water.

## References

- Ahiale E, Serfoh-Armah Y, Kortasi B. 2010. Hydrochemical analysis of groundwater in the Lower Pra basin of Ghana. *J Water Resources and Protection*. 2: 864-871. [Accessed 2023 Feb 22]  
<http://csirspace.csirgh.com/bitstream/handle/123456789/180/Hydrochemical%20Analysis%20of%20Groundwater%20in%20the%20Lower%20Pra%20Basin%20of%20Ghana..pdf?sequence=1&isAllowed=y>
- Anornu G, Gibrilla A, Adomako D. 2017. Tracking nitrate sources in groundwater and associated health risk for rural communities in the White Volta River basin of Ghana using isotopic approach ( $\delta^{15}\text{N}$ ,  $\delta^{18}\text{O-NO}_3$  and  $^3\text{H}$ ). Elsevier. 603: 687-698. [Accessed 2023 Feb 22]  
<https://www.sciencedirect.com/science/article/pii/S004896971730236X>

Armah F, Ekumah B, Yawson D, Odoi J, Aftiri A, Nyieku F. 2018.

Access to improved water and sanitation in sub-saharan Africa in a quarter century. *Heliyon*. 4(11) [Accessed 2023 Feb 24]

<https://www.sciencedirect.com/science/article/pii/S2405844018349132?via%3Dihub>

Barrie A, Swaray A, Barrie M, Beah J. 2021. Evaluating drinking water treatment methods in the Njala University and neighboring Mokonde communities in Southern Sierra Leone. *Natural Resources*. 12(8): 257-270. [Accessed 2023 Feb 26]

<https://www.scirp.org/journal/paperinformation.aspx?paperid=111344#ref5>

Denk T, Mohn J, Decock C, Lewicka-Szczebak D, Harris E,

Butterbach K, Kiese R, Wolf B. 2017. The nitrogen cycle: a review of isotope effects and isotope modeling approaches.

*Elsevier*. 105: 121-137. [Accessed 2023 Feb 25]  
<https://www.sciencedirect.com/science/article/pii/S0038071716305946>



- Liu X, Wang Y, Li Y, Liu F, Shen J. 2019. Multi-scaled response of groundwater nitrate contamination to integrated anthropogenic activities in a rapidly urbanizing agricultural catchment. *Environmental science and pollution research*. 26(34): 34931-34942. [Accessed 2023 Feb 27] <https://www.proquest.com/agricenvironm/docview/1986207862/7BB6807E75B248ABPQ/3?accountid=14505>
- McGill B, Alchenko Y, Hamilton S, Kenabatho P, Sylvester S. 2019. Complex interactions between climate change, sanitation, and groundwater quality: a case study from Ramotswa Botswana. *Hydrogeology Journal*. 27(3): 997-1015. [Accessed 2023 Feb 26] <https://www.proquest.com/agricenvironm/docview/2165547562/3FB466BD92BD4101PQ/2?accountid=14505>
- Teklu B, Hailu A, Wiegant D, Scholten B, Van den Brink P. 2018. Impacts of nutrients and pesticides from small- and large-scale agriculture on the water quality of Lake Ziway, Ethiopia. *Environ Sci Pollut Res*. 25: 13207-13216. [Accessed 2023 Feb 25] <https://link.springer.com/article/10.1007/s11356-016-6714-1>

Toure A, Wenbiao D, Keita Z, Dembele A, Elzaki E. 2019.

Drinking water quality and risk for human health in

Pelegana commune, Segou, Mali. J Water and Health.

17(4): 609-621. [Accessed 2023 Feb 25] [https://](https://iwaponline.com/jwh/article/17/4/609/67793/Drinking)

[iwaponline.com/jwh/article/17/4/609/67793/Drinking](https://iwaponline.com/jwh/article/17/4/609/67793/Drinking)

[water-quality-and-risk-for-human-health](https://iwaponline.com/jwh/article/17/4/609/67793/Drinking)

NETWORK ANALYSIS:  
SOCIAL CONTAGION  
DYNAMICS AND  
INFORMATION DIFFUSION

CHI CHEN



---

*WRITER'S COMMENT: This formal scientific literature review was written in response to the review article assignment of Dr. Brenda Rinard's UWP 102B (Writing in the Biological Sciences) course. Network science is a field of interest for me because of its proximity to one of my research projects and my aspiration to promote preventative health. My role is to identify highly connected assets to help enhance the population-level behavior change from public health interventions in South Sacramento. Becoming well-versed in applications of social network analysis and community-based interventions will help me identify how to best approach a large population at once using the role of linkage influence in social networks. The search for a cure to chronic diseases is essential; however, prevention is far cheaper and more time-efficient than a cure. Through this literature review, I hope to promote the usage of social network framework to study social contagion dynamics and information transmission in public health research. I would like to offer my sincere gratitude to Professor Rinard for her expert guidance and support in approaching my review.*

*Instructor's Comment: In my Writing in the Biological Sciences course, I always ask students to choose topics that are practical for them. Because Chi wants to work in public health, and is interested in interdisciplinary work in this area, she chose to examine how social networks affect health outcomes. To investigate this question, she focused on network analysis, a relatively new, interdisciplinary, research tool. She dove into the international literature on this topic, and presents a balanced perspective on these studies' strengths and weaknesses.*

*Through her careful reading and analysis, Chi illustrates how interdisciplinary, international, research can improve our understanding of complex scientific topics.*

*-Brenda Rinard, University Writing Program*

## **Abstract**

Network medicine and network analysis are cost-effective and time-efficient ways to analyze social contagion dynamics (behavior or conditions spreading spontaneously through groups) and improve disease management strategies. Linkage influence in social networks enables service providers to reach a large population at once with less manpower and resources. It is possible to amplify the role of family or friend networks to transmit a number of health-promoting behaviors. The roots of network analysis can be traced back to an amalgam of disciplines, including mathematics (graph theory and topology), anthropology (kinship systems), and sociology (social ties and structure). Using mathematical tools and graph neural networks, researchers can develop relatively accurate clinical hypotheses that are more efficient than current metabolic syndrome factors. Agent-based models feature simulations that enable researchers to explore public health interventions in small-scale networks. Experimental trials inform the dynamic spread of disease, provide important implications for efficiently developing interventions as well as allocate resources for disease prevention in interpersonal networks. Since social communities often form a scale-free network, social network analysis (SNA) introduces a new framework that will contribute to enhanced medical outreach, better understanding of disease transmission, and greater access to quality preventive care.

*Keywords:* network analysis, social network approach, social contagion, network-based science

## Introduction

**N**oncommunicable diseases (NCDs), including heart disease, stroke, cancer, diabetes and chronic lung disease, are collectively responsible for 74% of all deaths worldwide [1]. Social and cultural forces shape almost every aspect of infectious and non-infectious disease transmission in human populations. For directly transmitted infections, pathogen transmission relies on human-to-human contact where kinship and societal structures create contact patterns that then determine epidemic dynamics [2]. Social, economic, and cultural forces also affect patterns of exposure, infection outcomes, the diagnosis and reporting of cases, and the adoption of interventions.

Network analysis is a research method and scientific paradigm that explores what is the most impactful way to approach community members for disease prevention. Highly connected and influential individuals and assets in networks can enhance the population-level behavior change from public health interventions. Network research studies usually fall short of case-control groups to compare the effects of social ties under different experimental conditions and identify if social network findings can be generalizable to other populations. Further research is needed to investigate the trial and error of the different disciplines, including applications of network centrality in graph theory and social ties. This review illustrates the strengths and deficiencies of network-level metrics in tackling the transmission of disease and information in public health.

### **Quantitative Graph Theory: The Structural Quantification Of Information**

The emerging tools of neural graph network models offer advancement in the identification and prediction of chronic diseases. In particular, Lu et al. concluded that Graph Neural Network (GNN) techniques and a network-science approach facilitates drastic improvements in population health and risk factor discovery.

Administrative data stems from the Commonwealth Bank Health Society, where researchers tracked the medical services of around 1.2 million de-identified patients receiving medical services from the year 1995 to 2018 [3]. Combining weighted patient networks (WPN) and GNN, Lu et al. created neural networks and accurate prediction models to learn about the latent relationship between patients (who have cardiovascular disease or chronic obstructive pulmonary disease) and their risk of developing chronic diseases. The inclusion of bipartite graphs matches an undiagnosed patient's health trajectory with the networks, displaying comorbidity patterns which are confirmed by a shared molecular mechanism using disease-gene interactions. The results show that a network-based model achieves an accuracy of 93.49% for cardiovascular disease prediction and 89.15% for chronic pulmonary disease prediction [3]. Similar applications of the network analysis techniques and graph theory revolved around identifying the risk of Type 2 Diabetes (T2D) and tracking patterns of comorbidities and clustering membership. The researchers filtered hospital admission and discharge data on patients' comorbidity footprints, sampling the records of 4600 patients [4]. Khan, et al. generated a networked view of chronic disease progression such as Comorbidity Network creation and calculated the risk scores for different demographic, behavioral and network factors. They match an undiagnosed patient's health trajectory with the comorbidity network, yielding a prediction accuracy between 82% to 87% [4]. The researchers have used the network theories and administrative data to systematically develop a research framework that identifies patients whose disease footprints broadly follow a similar trajectory of patients with pre-existing comorbidities.

Both study results suggest an alternate, possibly more advanced method to predict disease outcomes and risk factors other than metabolic syndrome factors such as abdominal obesity and impaired fasting glucose. The proposed framework has potential in the identification of high-risk chronic disease cohorts and reduction of the burden of acute care hospitalization.

Any shortcomings of the study derive from constraints such as limited real-world health datasets, underestimation of a patient's comorbidities, and difference in the quality of coding in hospitals [3, 4]. Regardless of the technological constraints, graph theory and social network analysis-based methods can be effectively used for disease risk prediction and optimize the usage of administrative data more effectively. Quantitative network information can help identify at-risk populations, allow providers to conduct medical outreach, prevent or catch the disease early, hence giving people better access to quality preventive care.

### **Applications Of Agent-Based Models And Simulations**

Agent-based simulation can be used in concert with behavioral diffusion campaigns and peer-to-peer social influence to spread reliable health information and behavior change. While graph theory provides insights about chronic disease presence, agent-based models (computer simulations used to study the interactions between people, places, time) explore the impact of simulations and interventions. Shi et al. nested different agents in the social network to determine their effects on anti-obesity interventions in China [5]. The agents include individuals with a large number of connections or the same gender, age, and body weight (BMI) as the participants. Study results demonstrated individuals with similar traits such as Body Mass Index (BMI) would cluster together. The most highly connected individuals had a disproportionate effect on the population due to its tremendous number of neighbors [7]. Targeting the most connected participants minimizes the average population weight and BMI, while generating a reduction of 2.70% and 1.38% in overweight and obesity prevalence [5]. A possible downfall is lacking the ability to build a network with full fidelity to reality as researchers left out data such as number and strength of connections among individuals in the same community. Regardless, the experiment has proved effective in reducing the prevalence of metabolic factors such as high BMI values.

A study examining the social contagion of attitudes in childhood vaccination in parental social networks yielded similar experimental conclusions about social network information transmission. In this study, Christodoulou et al. concluded that the position of a person within a social group can heavily influence the diffusion of positive vaccination messages to other community members [6]. The researchers captured changes in the network structure based on changes in attitudes resulting from the social influence effect. Centrally located individuals who share a similar culture (beliefs, values, and behaviors) will more likely cause a change in the childhood-vaccination attitudes and will sustain a long-term change at 3 months follow-up, compared to randomly located people [6]. Consequently, one of the most effective disease management approaches across public health studies is targeting the best-connected individuals on the edge of a cluster for disease intervention [5]. Examining the social contagion of attitudes in childhood vaccination can help prevent the spread of these diseases in a larger population.

A common theme throughout social networks and the spread of pathogens is the formalization of disease as a simple contagion. The transmission of pathogens and information operates similarly as the dispersion of beliefs and behavior. Campbell et al. proposed a hybrid model in which the spread of complex contagions, such as anti-vaccination norms, can directly impact the spread of contagions such as viruses. Their model is split into two time periods where the spread of both vaccine refusal and the infectious disease are modeled on a static social network of 5000 individuals [2]. In the first time period, they simulate the diffusion of negative vaccination sentiment and vaccine refusal on a social network. In the second time period, the researchers simulate the spread of the infectious disease against which the vaccine confers complete immunity. The spread of anti-vaccination norms can transform networks (that would otherwise be inoculated from epidemic outbreaks) into communities that are highly susceptible to the spread of pathogenic contagions like measles [6]. The researchers,



however, do not explicitly simulate the spread of positive vaccination sentiment. Positive sentiment is treated as a default position for individuals who do not adopt negative vaccination sentiment; but, this may affect the public opinion component of the study. The researchers have also made additional simplifying assumptions that may contribute to scientific gaps: general exposure to the disease, general exposure and simple contagion, and general exposure and complex contagion during the opinion formation process. In spite of that, the model is a valuable line of work that quantifies how health behavior connectivity varies in relation to behavioral traits and individuals within a social network. Given the structure of social and information networks, healthful behavior and information will diffuse and branch out into the broader population through a cascading effect.

### **Trial and Error: Analysis Of The Diffusion Of Behavior And Knowledge**

Experimental trials evaluate network characteristics to inform the dynamic spread of disease, provide important implications for efficiently developing interventions as well as allocate resources for disease prevention. In an effort to understand how knowledge and behavior can spread across interpersonal ties, Kim et al. constructed an experiment to examine how targeting highly connected and influential individuals in networks could enhance population-level behavior change. The researchers set up a randomized controlled trial of a network targeting algorithm and delivered two public health interventions: multivitamins for micronutrient deficiencies and chlorine for water purification. A total of 32 villages in rural Honduras were randomly assigned to methods such as highest indegree positions in the network, nominated friends, versus random selection [7]. Several weeks after the intervention method, Kim et al. tracked the diffusion of products and knowledge among all villagers. Methods to identify hubs of influence and influential people around the hubs may prove useful in the design of more

cost-effective public health campaigns in settings where there are limited resources or broadcast intervention. Targeting the most highly connected individuals produced no greater adoption of either intervention, compared with random targeting [7]. Previous studies drew a parallel between centrally located individuals and behavior/information diffusion; however, the Honduras research outcomes did not suggest a strong trend between the two factors [2, 5, 6]. Potential pitfalls of the data collection derive from a sample size that is not representative of the larger population as it was limited to the cluster of rural communities. There was not a standard of comparison as to how the social network theory can be applied under different settings, especially since social media plays an integral role in everyday urban and suburban life.

Researchers should combine standardized control groups and self-testing with a social-network based approach. In a separate study, Sheira et al. harnessed the power of peer influence within men's close social networks and leveraged new technologies such as HIV self-tests and point-of-care PrEP adherence assays to increase men's HIV testing rates. Utilizing beach management unit (BMU) registries of 38,000 fishermen operating in three Lake Victoria fishing communities in Kenya, the researchers completed a census and social network mapping to identify their close social networks [8]. Network clusters identified by a socially-central lead ("promotor") and selected to ensure maximal separation between treatment and control will be randomized. Promotors in both will receive basic HIV training; intervention promotors are further trained in HIVST to distribute kits to their cluster, while control promotors will distribute to their cluster vouchers for free HIVST at nearby clinics. The researchers hypothesize a greater rate of HIV testing will be observed after three months among men in networks that receive the intervention compared to the control group [8]. In this case, although there were control groups, these study findings will only be generalizable to the population studied (i.e. men in fishing communities and inland fisheries settings in sub-Saharan Africa). Poor generalizability, where results can only be applied

to a very narrow population or situation, is a common pattern in research outputs across social network controlled trials [7].

In a small-scale public health intervention method, chimpanzees have been used to understand the relationship between morbidity and the social transmission of acquired behavior or information. Julie et al. initiated the first retrospective study using network analysis to quantify contact heterogeneity in wild apes in Kibale National Park. Small-scale network trials in chimpanzee communities serve as valuable beginner insight to network centrality. The researchers use field observations of behavioral encounters to predict community-wide infectious disease risk within a wild chimpanzee community (n=48) over a 9-month period [9]. They identified traits of highly connected individuals that might contribute to pathogen spread and analyzed empirical wild chimpanzee contact networks to predict implications for infectious disease risk. Network analysis can identify potential superspreaders, individuals with disproportionately high contact levels, that could be targeted for vaccination, treatment or isolation [6]. Studies of chimpanzee networks can serve as a basis for human contact networks to explore the presence of superspreaders and enhance the understanding of transmission dynamics for SARS and HIV/AIDS. Judging from comparisons of anatomy and genetics, since humans are most closely related to chimpanzees, the behavioral variation data can be incorporated into the creation of disease management strategies for any wildlife population. Social network theory is a continuously maturing discipline so future research studies can cross-pollinate, re-evaluate, and expand the pre-existing framework to ensure better generalizability.

## **Conclusion**

Network analysis offers a valuable approach to health systems and services researchers as it offers a means to uptake public health interventions and identify opinion leaders, influencers, clusters in the network. In the past decade, there have been emerging

network centrality research surveys and observational or cohort/panel studies; however, more research is needed to evaluate the results in public health interventions. Health systems and services researchers' in-depth analysis of the literature signaled that more evidence is necessary from randomized controlled trials or other studies. In future studies, researchers will seek how network centrality methods can address the lack of generalizability of these systems. Nonetheless, the rapid growth of peer-to-peer and other social influence plays a central role in patterns of dieting, exercising, getting screenings, and additional behavior change that can prevent chronic disease worldwide. Network centrality entails a shift in focus from one-to-one social interactions to the community-wide interactions, meaning service providers can achieve high-quality healthcare outcomes in a large-scale.

## References

- Robert Beaglehole, et al. 2013-2020. "Priority actions for the non-communicable disease crisis," The Lancet, April 6, 2011; WHO, Global action plan for the prevention and control of NCDs.
- Campbell, E., Salathé, M. 2013. Complex social contagion makes networks more vulnerable to disease outbreaks. *Sci Rep* 3, 1905. <https://doi.org/10.1038/srep01905>
- Lu, H., Uddin, S. 2021. A weighted patient network-based framework for predicting chronic diseases using graph neural networks. *Sci Rep* 11, 22607. <https://doi.org/10.1038/s41598-021-01964-2>
- Khan, A., Uddin, S., et al. 2019. Chronic disease prediction using administrative data and graph theory: The case of type 2 diabetes. *Expert Systems with Applications*, Volume 136, Pages 230-241, ISSN 0957-4174, <https://doi.org/10.1016/j.eswa.2019.05.048>
- Shi L, Zhang L, Lu Y. 2020. Evaluating social network-based weight loss interventions in the Chinese population: An agent-based simulation. *PLoS ONE* 15(8): e0236716. <https://doi.org/10.1371/journal.pone.0236716>

- Christodoulou, A., Konstantinou, P., et al. 2022. A Protocol of a Pilot Experimental Study Using Social Network Interventions to Examine the Social Contagion of Attitudes Towards Childhood Vaccination in Parental Social Networks. *Health Psychology Bulletin*, 6(1), 13–25. DOI: <http://doi.org/10.5334/hpb.37>
- Kim, David A, O'Malley, James A, et al. 2015. Social Network Targeting to Maximize Population Behavior Change: A Cluster Randomised Controlled Trial. *The Lancet*, vol. 386, no. 9989, pp. 145–153., [https://doi.org/10.1016/s0140-6736\(15\)60095-2](https://doi.org/10.1016/s0140-6736(15)60095-2).
- Sheira, L.A., Kwena, Z.A., Charlebois, E.D. et al. 2022. Testing a social network approach to promote HIV self-testing and linkage to care among fishermen at Lake Victoria: study protocol for the Owete cluster randomized controlled trial. *Trials* 23, 463. <https://doi.org/10.1186/s13063-022-06409-3>
- Rushmore, Julie, et al. 2013. “Social Network Analysis of Wild Chimpanzees Provides Insights for Predicting Infectious Disease Risk.” *Journal of Animal Ecology*, vol. 82, no. 5, pp. 976–986., <https://doi.org/10.1111/1365-2656.12088>.

## EAST ASIAN AMERICAN FLAVORS OF HOME: EVOLUTION BY ADAPTATION

SOFIE KANAYAMA



---

*WRITER'S COMMENT: French gastronome Brilliat Savarin once said in 1825, "Tell me what you eat, and I'll tell you who you are". This aphorism cannot be chalked up to a mere nutritional adage, but herein lies an understanding of the tightly knit relationship between food and identity. It has the power to connect and divide, and through the act of cooking and eating, we continue to forge our distinctive social identities. In this article, I observe the ways food can adapt, evolve, and bond people through times of migration and dislocation. When Professor Abramsky tasked my journalism class with writing a feature article on any issue, with the premise that we were to interview at least 5 people, I immediately knew that I would write about food – regardless of who you are, we all need to eat. My hope is that through this article, the kitchen becomes a slightly less daunting place, knowing that a dish doesn't need to be 'authentic' to be enjoyed or receive praise. And finally, I hope that this story encourages readers to eat with someone today, no matter what that meal may look like.*

*Instructor's Comment: Sofie Kanayama wrote her piece on food culture amongst Asian immigrant communities in California while a student in my UWP 104c journalism class. From the get-go, her enthusiasm for her topic shone through. She brought a passion to her reporting that only occurs when the writer is genuinely immersed in, and fascinated by, the ideas and people and events that she is covering. I have to admit that, when Sofie first presented the idea to me, I worried that it wouldn't be a large enough topic to merit a 2,000 word feature article. I rapidly realized my mistake; she report-*

*ed it thoroughly, did marvelous, eye-opening interviews, and conveyed a sense of sheer joy to readers about the cuisines that she was delineating. By the time she finished the final version of her article, I felt like I had been invited into a VIP tasting-room for foods that, until now, I had only experienced the light versions of. It was, in other words, a truly enjoyable literary meal. Sofie's winning of a spot in the Prized Writing publication is richly deserved, and I hope that, over the coming years, she continues to use her writing skills to bring these foods and recipes and culinary cultures to a broader audience.*

*- Sasha Abramsky, University Writing Program*

“White peppercorn and five spice”. To 20-year-old UC Davis student and member of TAO (Taiwanese American Organization) Ashley Chang, this is what home tastes like. White peppercorn and five spice are both warm, quintessential spices that shape Taiwanese cuisine, playing essential roles in iconic dishes such as braised tea eggs and Taiwanese beef noodle soup. “It’s a mixture of two spices that my dad would use on top of everything he cooked,” Chang explains – “Now I put it on top of everything too.”

Design and Communications major Chang and I met on a study abroad program in the United Kingdom during the summer of 2022. As we sat on the tall chairs in the communal kitchen of the newly built student accommodation of Edinburgh Napier University, we bonded over the soups we had both grown up eating despite being in different cities, states, and even countries. Beef noodle soup, hotpot, and oxtail soup with daikon radish – these were the flavors of home, each tied with particular celebrations and events across our lives. “I’ll make it for you when we return to Davis,” she promised.

For people in the Taiwanese diaspora, home is more of a concept than a physical place. It’s about the people, cultural belonging, and feeling at ease. We are shaped by the places we call home, but that place is a bit nebulous. Just as neighborhoods, cities, and countries



all change overtime, so do the corresponding foodways – foodways define the patterns of what we eat, as well as why, how, and under what circumstances. As a result of a complex web of differences in geography, food production systems, and culture, the vegetables found in local Taiwanese markets may highly differ from the ones in the United States. Yet what grounds us is a collective memory of the tastes and feelings invoked by a single location. These memories can be passed down generation by generation, even to those who have never lived in the motherland itself.

Neither Chang nor I have ever lived in Taiwan, yet the food we make serves as a callback to our heritage and acts like a conduit of connection to our families.

It's a Wednesday school night when Chang welcomes me into her warmly lit apartment kitchen, where a metal pot is boiling over the gas stove. The kitchen is an open space with cream color tile floors, looking out to the living room. With a broken stove fan, the window by the sink gets propped open, and a cool breeze drifts in, lightly blowing on the acanthus plant sitting on the cupboard. I take a seat by the kitchen counter where across, she ties her jet black hair up into a ponytail and dashes back and forth between the stove, the cupboards, and the drawers; she is anxious to be a welcoming host.

Anticipation grows as she serves me the bowl of soup she had labored over – it was four months in the making since she promised a piping hot bowl of Taiwanese soup.

The soup was inedible. One sheepish phone call back home revealed that she was in fact missing all of the key ingredients to pork bone and daikon soup – the meat and the seasoning.

She had, in fact, served me radish water.

Perhaps Chang's experience of a clumsy recreation of the foods of our homes isn't such an out of the ordinary experience. In another instance, she describes a failed attempt at making the black sesame mochi she grew up eating in Taiwanese night markets. With this scenario, she comically ended up with a product too sticky to shape into dainty balls, instead resorting to chomping down on a slab of steamed rice flour.

Across the United States, millions of Asian Americans students fumble around the kitchen to recreate foods reminiscent of their homes. Often what results is a less than perfect version of what was envisioned, but perhaps it can also be seen as a diversification and reshaping of the American food landscape.

According to the Pew Research Center and the U.S. Census, Asian Americans account only for 5.7 percent of the nation's population, yet occupy 15 percent of the Californian populace. More than that, nearly half of Asian Americans in the U.S. live in the West, and with 30 percent in California alone, Asian Americans make up 43.8 percent of the UC Davis population. Nationally, Asian Americans are the fastest-growing ethnic group in the country, their numbers increasing by 81 percent between 2000 and 2019, from roughly 10.5 to 18.9 million.

As we sit in her office studded with student artwork from her Asian American Contemporary Issues class, Dr. Kieu-Lihn Valverde, professor of Asian American Studies at UC Davis, explains that ever since the Gold Rush in the mid-1800s, "Asians have widely immigrated to California in search of educational and economic opportunities." In the following decades, these newly established communities faced obstacles from the Chinese Exclusion Act of 1882 to the internment of Japanese Americans during World War II. Since their arrival, California Asians have struggled with their ethnic identity and finding a sense of belonging, yet this has not stopped them from participating in Californian life while maintaining their own cultural traditions – "Food has played such a large role in cementing who we are as a people," Valverde says as she scans the collaged painting of the map of Hanoi, Vietnam on

her wall. This is where she had immigrated from at the age of five due to her father's airline job. Pointing to the narrow alleyways on the aerial view map, she tells me "this is where the good food is – breakfast food to be exact." Since moving to California, gone were the days of running down the bustling alleyways for a hot bowl of phở. This, however, is precisely what inspired her to begin cooking her own version. Reflecting upon the history of Asian American cuisine, Valverde relays that from the proliferation of Chinese restaurants adapting dishes to suit the American palate, to the incarcerated Japanese Americans incorporating government commodities like hot dogs and ketchup into their traditional diets, our food culture has been marked by a necessary adaptation to make a hybrid cuisine.

This quality of adaptation is reflected in the contemporary kitchen as well. As 24-year-old Korean American Hayoung David Oh puts it, "it's always a clumsy attempt at first, but it's a learning curve." It is a learning curve of stocking our kitchens with the basics necessary to create the dishes of our heritage, as well as knowing how to work with what is available.

While Chang may have a pantry stocked with white peppercorn and five spice, Oh has learned to fill his with Gochujang, sesame oil, and dried anchovies. "With those basics, I could probably make anything," he claims.

"I, like most Asians, grew up in a culture of food," Oh reflects – he was born in Denver, Colorado, then constantly moved about the U.S. with his family starting from the age of two. His father's job as a pastor led him to migrate all over Southern California, Michigan, Indiana, Central California, and the Bay Area, providing him with a different relationship to food in each location. Now, having recently finished his master's program in public health, he lives alone in Ann Arbor, Michigan, applying to PhD programs in food studies.

Before moving away from home, Oh says that the scope of his kitchen knowledge began with reheating takeout in the microwave and ended at boiling water for pasta. Learning to cook only came about during an era of desperation in graduate school. “When I first moved to Michigan, the only thing I had in my kitchen was one chicken breast, some oil, a nonstick teflon pan, and a butter knife. I also had a plastic fork, but it melted on day one,” Oh recalls. The first dish he ever made was, in fact, that chicken breast – one that he managed to simultaneously burn on the outside and maintain raw on the interior. Since his initial foray into cooking, Oh has marked his territory in Korean food and bread baking, drastically growing in his fluency around the kitchen. Today, he hosts dinners for his friends roughly three times a week, often serving the Korean cuisine that his mother cooked for him as a child. One such dish is doenjang jjigae, a staple Korean stew made with fermented soybean paste, potatoes, zucchini, onions, and tofu. To Oh, this is what home tastes like – “it warms you from the inside, and feels like a hug from a family member,” he says. “Without all of the vegetables, it feels incomplete, but sometimes I’ll start making substitutions – like carrots – this is weird.”

This inability to keep one’s pantry and fridge stocked with all the ingredients needed to make our comfort foods seems to be a reality for many Asian Americans on campus. After all, fen zheng rou powder and winter melon blocks might not be the easiest things to find in your local Trader Joes.

While some, like Oh, take to making substitutions, and others explore other cuisines all together, Iris Lee, a sociology student at UC Davis, turns to other means. “I got this on Weee!” she says, while scrolling through her computer; the screen displays a myriad of East Asian food products from lychee juice to shrimp chips. As we sit abreast in front of the pristine whiteboards of the newly built Teaching Learning Complex on campus, she reviews her online order history. According to the website, “Weee! is a California-based online grocery platform that offers Asian foods, specialty products, and everyday staples” delivered right to your door. “This

is the package I was waiting for the other day, when I missed our study session,” she explains. Taking a closer look at her order, I see that she has purchased a slew of frozen pork buns, Korean instant noodles, Chinese Chicken flavored Cheetos, raw salmon, and chicken lumpia. “I’ve been trying out a bunch of Filipino items lately,” she mentions, when asked about the lumpia.

Lee claims that Weee! has made Asian ingredients more accessible to her. “I’ve looked at the Asian markets around Davis, but they are often more expensive and lack variety,” she states, showing me the bottle of Chinese dark soy sauce purchased for a dollar cheaper than what Kim’s Mart, downtown, asks for. It isn’t just snacks and pantry staples either— her receipt shows that the 2 pound pack of bok choy she bought was the same price as the 6.3oz. pack offered at Trader Joe’s.

To Lee, it is important for her to collect these Asian ingredients as a way to connect back home. After moving out to Davis for college, she too, began cooking for comfort – “My stomach can’t last multiple consecutive days on western food,” she says, “I try to cook dishes that I’m familiar with because it helps me recall fond times with family. But it’s hard to compile all the ingredients I need in order to make a dish in the same way that my mom does.”

Taiwanese immigrant Yijean Tsai, age 55, is a mother of three girls and a wife to a Japanese man. Her culinary repertoire consists mostly of Taiwanese cuisine, with a dash of Japanese home cooking. “How long will this take?” she asks, as we sit down for an interview at her dining table on a Monday afternoon, “I have something on the stove.” Unsurprisingly, Tsai is in the middle of making Lu Rou Fan, the ultimate Taiwanese comfort food of pork belly braised in a rich, fatty broth, boiled eggs, and tofu skin, all topped over steaming white rice, ready to burn your tongue – it’s a dish that she falls back on as a staple in her household.

At age 14, Tsai moved to California with her parents. “My family never cooked in Taiwan,” she observed. With all the street food readily available in the alleyways, there was no reason to. “But after moving to California, my father began cooking, because he craved the foods he liked.” They made braised pork and clear broth soup. In examining her own culinary repertoire, Tsai explains “Everything we eat now is passed down through the generations – the food I cook for my kids today was passed down from my parents, and of course their parents more or less ate the same things too. The foods that you prefer today heavily depend on what your parents fed you – Taiwanese people like their Chinese food, so Italian cuisine won't sell in a small town like Tainan,” she posits, as Tsai recalls walking past a sneaker store in Tainan with the facade comically labeled “Italian Pizza and Pasta” in bright orange letters.

When asked if she would ever consider ordering Asian ingredients from Weee!, Tsai says “No, when I go to the store in California, I've learned not to look for certain things – like wax apples and fresh bamboo – you'd never expect to find those things here.”

Perhaps, this challenge calls for the embrace of local, seasonal produce that our land has to offer – the hallmark of California cuisine. As a deviation from its most traditional form, some may turn their nose up to Hayoung's ragtag doenjang jjigae, deeming it inauthentic. But the quest for authentic food demands two things: It demands that food can be statically defined and consumed by the cultural majority, and it demands a cook who can stand in as a representative of the culture of the food from which it came from.

The real question is this: Who is it authentic to?

Perhaps, the evolution of traditional cuisines through adaptation is what marks the essence of Asian American food – it is the marriage between seasonality and the foods of the diaspora that marks its beauty and the myriad of stories to be told. When dishes depart from their original form, they may not be traditional, and yet still remain authentic to the cook. A common voice between all of the students interviewed reveals that in attempts

to recreate our home foods, ingredients are more often than not substituted out, and dishes evolved. It seems the only constant in Asian American food is that it will continue to change, with each successive generation. Despite obstacles such as a shortage of time, tools, expertise, and traditional ingredients, Chang, Lee, Oh, and Tsai all cook because it connects them to the people whom they love and have shaped them. This is the familial grounding that allows for the finding of belonging within the act of making food and setting the table, transcending both time and location.

## INTERSECTION OF DISABILITY AND WELFARE IN CALIFORNIA: A POLICY ANALYSIS

MANPREET KAUR



---

*WRITER'S COMMENT: Growing up in a small suburb of South Sacramento, CA, I witnessed the harsh economic and social conditions by which parents with disabilities cared for their children. Needing to sleep hungry or study under the bright beam of streetlights due to electricity cuts are feelings children in my community are too familiar with. These experiences have shaped my goal of serving low-income communities and investigating economic and political intersections that directly influence members of said communities. So, when Dr. Lore assigned us an Informative Advice Article examining a specific issue and revealing areas of need, I recognized this as an opportunity to evaluate our welfare system's effectiveness in meeting the basic needs of households headed by disabled parents. To present these complexities, I share the story of a loved one, who suffers from a common yet serious chronic illness that prevents her from working. Challenging public perceptions and political actions was risky, but I believe this critical discourse is needed to enhance the quality of life for vulnerable communities.*

*Instructor's Comment: In UWP 101: Overcoming Life-Changing Moments, students work on a quarter-long project that begins with a narrative in which they interview someone who has gone through a hardship that has drastically changed their life and culminates into an informative advice article that is well supported with secondary research. Manpreet's passion for helping people with long-term disabilities became apparent when she became concerned that she had too much information to work with. Her dedication to exposing the*



*disparity between the needs of the disabled population of California and the policies that limit access to funds is evident in how well she argues each of her points, anticipating any disagreements that might arise among those who want to limit benefits to this population. Manpreet does not simply expose the problem of inadequate benefits but also makes reasonable suggestions to young advocates on how they may be able to fight for more appropriate benefits for the disabled population.*

*-Elisabeth Lore, University Writing Program*

Jasdeep" is a mother of four children who was diagnosed with Non-alcoholic fatty liver disease (NAFLD) on October 25, 2020 (Kaur Interview, 2023). While she was fortunate to see a physician at her local emergency room for the unbearable pain, she and her children rely on CalFresh, food banks, and donations to cover monthly expenses. She was denied Social Security benefits two times because her medical condition, NAFLD, was not a qualifying disability. As she shares how her children struggled to make ends meet during her bedridden years, the sorrow and pain in her voice is enduring.

Remarkably, Jasdeep lives in California, the dynamic powerhouse on track to become the 4th largest economy in the world, only surpassed by the United States, United Kingdom, China, and Japan (Winkler, 2022). The gross domestic product of California has seen a steady growth since 2000 to reach \$3.4 trillion, equivalent to Germany. Yet, amongst these achievements, politicians and young advocates know California is also home to a vulnerable population destitute of a comfortable lifestyle. California has the largest disabled population in the nation.

According to the 2021 American Community Survey conducted by the United States Census Bureau, 4.3 million Californians lived with a mental, physical, or emotional disability (American Community Survey, n.d.-a). While this accounts for

only 11.2% of California's population, 4.3 million is 10.2% of the nation's disabled population, the largest number of all states (American Community Survey, n.d.-b). Overwhelming evidence also suggests disabled individuals are equally as likely to become parents than those without disabilities (Horner-Johnson et al., 2016; Kaplan et al., 2019). Despite these prevailing statistics, the utility and access of public resources, such as Social Security and CalFresh, are unexplored.

Given that California has one of the largest economies worldwide, California's budget towards programs and new initiatives is massive. Just recently in 2022, the historic 2022-2023 state budget by California Governor Gavin Newsom included a \$100 billion budget surplus—the largest in state history (Senate Budget and Fiscal Review Committee, 2022). However, after a closer analysis, only a small percent of the budget meant to support vulnerable populations directly supports that cause; in other words, only a small amount actually reaches the hands of vulnerable populations.

As known, the legislature proposed an 8.6% grant increase to the Supplemental Security Income program. The SSI program is the largest federally funded program under the Social Security Administration (SSA) providing monthly payments to individuals over the age of 65, who are partially blind, or have a medical disability that prevents them from working at least one year or leads to death (*Supplemental Security Income (SSI) | SSA*). The 8.6% is equivalent to a mere \$39 per month for individuals and \$100 per month for couples. This new increase provides SSI individuals \$1,134 per month and couples \$1,928 per month. Despite concerns that the state's regular reserves decreased by \$9 billion, young advocates need to acknowledge that the new benefits are still inadequate to live in California.

In 2022, the cheapest fair market rent in California was in northern eastern California's Modoc County, where a 1-bedroom apartment fared for \$609 and a 2-bedroom rented at \$801 (Rentdata.org, n.d.-a). A household in a 2-bedroom apartment headed by 1

SSI recipient would still yield \$333 for utility costs, non-Medicaid medical costs, and other basic essentials (assuming food is covered by other forms of public assistance). Politicians might argue that \$333 is feasible but, in reality, it is not. One cannot afford a car or the monthly car insurance payments. One cannot budget for a form of personal entertainment or even any unexpected expenses. Sure, people in Modoc County can squeak by every month, but people living in other areas with higher market values, like Sacramento, cannot. In 2022, the fair market rent of a 1-bedroom apartment was \$1,400 and \$1,756 for a 2-bedroom apartment (Rentdata.org, n.d.-b). It is apparent that people in Sacramento cannot squeak by with \$1,134. Individuals, including those with children, may face difficult choices on how to manage their tight income, such as eating less or cutting down on utilities.

On the bright side, the California Department of Social Services (CDSS) has made advancements to alleviate food insecurity in the disabled community. As of June 1, 2019, all SSI recipients are eligible to apply for federal assistance through the Supplemental Nutrition Assistance Program (SNAP) (Jim Borland, Acting Deputy Commissioner for Communications, 2020). CalFresh falls under SNAP and stands as the largest poverty alleviation program in California to date. The Public Policy Institute of California (PPIC) estimates “1 million Californians [were kept] out of poverty (2.6%), up from 500,000 in 2019” (*Poverty in California*, 2022). However, there is a caveat to CalFresh benefits. CalFresh guidelines clearly state that a family must earn \$0 in net income to receive the maximum benefit, depending on household size (Legal Services of Northern California, 2021). Consider the following example: A mother of four children, like Jasdeep, cannot work due to a physical disability. If she were to receive the maximum allotment for SSI and CalFresh, the total household income is \$2,324, 69.24% of the federal poverty level. If she wishes to work even part-time given her condition, she risks the \$2,324, as well as her health.

The strict asset and medical requirements of the SSA are equally as discouraging, oftentimes restricting stability and savings. To receive SSI, a bank account must not exceed \$2,000 for an individual or \$3,000 for a couple (*Supplemental Security Income (SSI) | SSA, n.d.*). These limits have not been updated since 1989. As per the 2022 SSI Annual Report released by SSA, after the first \$65 earned by work, 50 cents are deducted from Social Security benefits for every dollar worked (Social Security Administration, 2022). These disparaging income limits restrict disabled people. Michael Tanner, senior fellow at the Cato Institute and writer for the Orange County Register, believes these limits “encourage consumption while discourage thrift and savings” by penalizing ethical behavior (Tanner, 2022). Strict asset limits may also be contributing to the high poverty and low unemployment rates of this unique population. In 2021, 22.5% of disabled civilians lived in poverty, at a two-fold rate when compared to those without disabilities, 11.3%. The employment rate of disabled civilians was 39.4%, nearly half of the non-disabled population in California, 73.5% (*Institute on Disability, 2021*).

Now, politicians may argue the low employment is because people with disabilities choose to not work. However, there is evidence from 2018 of people with disabilities trying to find employment, even with the strict asset limits. According to the 2018 Disability Status Report of California conducted by Cornell University Yang-Tan Institute on Employment and Disability, 7.9% of the working-age population (ages 21 to 64) with disabilities was actively looking for employment in 2018 (*Erickson et al., 2020*). A recent survey of 22 families in California also found that people with disabilities on welfare were equally as likely to seek employment than individuals without disability and not on welfare (Kaur, 2023). Young advocates should recognize the issue is not the willingness to work but the mere difficulty of finding a job. If a person is lucky to find a job, they are at risk of benefit deductions within the following month. This is discouraging, at the very least.

While SSI prevents civilians from entering deep poverty, young advocates might be unaware of how limiting the program truly is. There are Californians who do not qualify under the strict definition of disability. As per the SSA, a person is disabled “if they can’t work due to a severe medical condition that has lasted, or is expected to last, at least one year or result in death” (*Facts | the Faces and Facts of Disability | SSA, n.d.*). Applicants must present themselves with a condition meeting the SSA medical criteria. Moreover, if one earns a dollar more than \$1,470 per month, the threshold for substantial gainful activity (SGA), they are deemed non-disabled regardless of their medical records (*Substantial Gainful Activity, n.d.*). Jasdeep is one of the many Californians who do not receive SSI benefits because her medical condition, NAFLD, which includes the inability to walk without assistance and stand on her feet for 5 minutes, is “not severe enough” (*Listing of Impairments - Adult Listings (Part A), n.d.; Kaur Interview, 2023*).

Politicians might argue that while all qualified individuals do not receive SSI, they could instead receive Social Security Disability Insurance (SSDI). However, young advocates should know that, as the name implies, SSDI is an insurance program, not welfare serving the needy disabled population. Under the SSA, SSDI is for individuals with a qualifying disability who have “worked long enough – and recently enough – and paid Social Security taxes on [their] earnings” (*Disability Benefits | SSA, n.d.*). Those who worked in the past are served well, but we cannot generalize this requirement of prior work experience to everyone living with disabilities.

Debates on this matter have paved the way for studies around the “culture of dependence.” People on welfare may grow dependent on government assistance, and as a result, hold different values than the general population. Researchers at Michigan State University studied this phenomenon in welfare recipients in 2003 and found that while welfare recipients favored job guarantees and government services, there was no distinct evidence of a culture of dependence when analyzing their beliefs on self-determination, political system, and the current economy (*Schneider & Jacoby,*

2003). They were “virtually identical to non-recipients.” The researchers also noted that the strong attitudes were likely due to demographic factors not part of the study. Although more recent data is needed to validate these results, such findings are critical for welfare reform.

If not for the incompetent nature of welfare recipients or a fostered culture of dependence, young advocates should address the following barriers preventing access to and the sustainable use of government support.

- Firstly, the asset limits of welfare programs need to reflect realistic amounts families can save to rebuild or sustain themselves. Asset limits from 1989 are not suitable in a time of great inflation and simply exacerbate existing disparities. Being restricted to \$2,000 or \$3,000 in a bank account not only keeps individuals from seeking other income sources while on welfare, but also restricts welfare access to those who have more savings, even if by a couple hundred.
- However, if not by adjusting asset limits, there needs to be increased awareness of savings accounts that do not jeopardize benefits, such as an ABLE Account (SPOTLIGHT ON ACHIEVING a BETTER LIFE EXPERIENCE (ABLE) ACCOUNTS, n.d.). Individuals who develop a disability before the age of 26 are allowed to save and invest money in an ABLE account for education, housing, transportation, or employment purposes. Young advocates could initiate workshops tailored to such resources and welfare applications so the community is aware of the ways to support themselves.

- Secondly, allow some flexibility with work earnings. Work requirements, as was done to Medicaid, are not necessary as they could put people with disabilities at risk (*Sommers et al., 2019; Wagner & Schubel, 2020*). Raising the SGA threshold and relaxing benefit deductions until a certain timepoint can prevent a person with a qualifying disability from denial because they earn a little.

## **Works Cited**

- American Community Survey. (n.d.-a). 2021 ACS 1-Year Estimates Subject Tables: Disability Characteristics [Dataset]. United States Census Bureau. [https://data.census.gov/table?q=percent+of+people+with+a+disability&g=010XX00US\\$0400000](https://data.census.gov/table?q=percent+of+people+with+a+disability&g=010XX00US$0400000)
- American Community Survey. (n.d.-b). 2021 ACS 1-Year Ranking Tables: Percent of People with a Disability [Dataset]. United States Census Bureau.
- Disability Benefits | SSA. (n.d.). <https://www.ssa.gov/benefits/disability/#anchor1>
- Erickson, W., Lee, C., & von Schrader, S. (2020). 2018 Disability Status Report: California. Ithaca, NY: Cornell University Yang-Tan Institute on Employment and Disability (YTI). [https://www.disabilitystatistics.org/StatusReports/2018-PDF/2018-StatusReport\\_CA.pdf](https://www.disabilitystatistics.org/StatusReports/2018-PDF/2018-StatusReport_CA.pdf)
- Facts | The Faces and Facts of Disability | SSA. (n.d.). <https://www.ssa.gov/disabilityfacts/facts.html>.
- Horner-Johnson, W., Darney, B. G., Kulkarni-Rajasekhara, S., Quigley, B. M., & Caughey, A. B. (2016). Pregnancy among US women: differences by presence, type, and complexity of disability. *American Journal of Obstetrics and Gynecology*, 214(4), 529.e1-529.e9. <https://doi.org/10.1016/j.ajog.2015.10.929>



- Institute on Disability. (2021). 2023 Annual Disability Statistics Compendium. University of New Hampshire. Retrieved March 1, 2023, from [https://disabilitycompendium.org/sites/default/files/user-uploads/v1-Accessible\\_2023\\_Annual\\_Disability\\_Statistics\\_Compendium\\_ALL\\_Final.pdf](https://disabilitycompendium.org/sites/default/files/user-uploads/v1-Accessible_2023_Annual_Disability_Statistics_Compendium_ALL_Final.pdf)
- Jim Borland, Acting Deputy Commissioner for Communications. (2020, November 6). Changes to California's Supplemental Nutrition Assistance Program. Social Security Matters. <https://blog.ssa.gov/changes-to-californias-supplemental-nutrition-assistance-program>
- Kaplan, K., Brusilovskiy, E., O'Shea, A., & Salzer, M. S. (2019). Child Protective Service Disparities and Serious Mental Illnesses: Results From a National Survey. *Psychiatric Services*, 70(3), 202–208. <https://doi.org/10.1176/appi.ps.201800277>
- Author. (2023). [Unpublished raw data on the disability and welfare status of California families].
- Legal Services of Northern California. (2021, December 20). How much in CalFresh benefits a household gets each month. LSNC Guide to CalFresh Benefits. <https://calfresh.guide/how-much-in-calfresh-benefits-a-household-gets-each-month>.
- Listing of Impairments - Adult Listings (Part A). (n.d.). <https://www.ssa.gov/disability/professionals/bluebook/AdultListings.htm>

Poverty in California. (2022). Public Policy Institute of California. <https://www.ppic.org/publication/poverty-in-california>

Rentdata.org. (n.d.-a). 2022 Fair Market Rent in Modoc County | RentData.org.

<https://www.rentdata.org/modoc-county-ca/2022>  
Rentdata.org. (n.d.-b). 2022 Fair Market Rent in Sacramento--Roseville--Arden-Arcade | RentData.org. <https://www.rentdata.org/sacramento-roseville-arden-arcade-ca-hud-metro-fmr-area/2022>

Kaur, Jasdeep (2023). Interview. Conducted by Kaur, Manpreet. Schneider, S. K., & Jacoby, W. G. (2003). A Culture of Dependence? The Relationship Between Public Assistance and Public Opinion. *British Journal of Political Science*.

<https://doi.org/10.1017/s0007123403000097> Senate Budget and Fiscal Review Committee. (2022). Final Version Budget Act of 2022 Preliminary Summary. Retrieved March 6, 2023, from <https://sbud.senate.ca.gov/sites/sbud.senate.ca.gov/files/Final%20Version%20Preliminary%20Summary3.pdf>

Social Security Administration. (2022). 2022 SSI Annual Report <https://www.ssa.gov/OACT/ssir/SSI22/>

Sommers, B. D., Bhasin, S., Blendon, R. J., Orav, E. J., & Epstein, A. M. (2019). Medicaid Work Requirements — Results from the First Year in Arkansas. *The New England Journal of Medicine*, 381(11), 1073–1082. <https://doi.org/10.1056/nejmsr1901772>

SPOTLIGHT ON ACHIEVING A BETTER LIFE  
EXPERIENCE (ABLE) ACCOUNTS. (n.d.).<https://www.ssa.gov/ssi/spotlights/spot-able.html>

Substantial Gainful Activity. (n.d.). <https://www.ssa.gov/oact/colasga.html>

Supplemental Security Income (SSI) | SSA. (n.d.). <https://www.ssa.gov/ssi>

Tanner, M. (2022, April 18). A Common Sense Fix to California's Welfare System. Orange County Register. <https://www.ocregister.com/2022/04/18/a-common-sense-fix-for-californias-welfare-system>

Wagner, J., & Schubel, J. (2020, November 18). States' Experiences Confirm Harmful Effects of Medicaid Work Requirements. Center on Budget and Policy Priorities. <https://www.cbpp.org/research/health/states-experiences-confirm-harmful-effects-of-medicaid-work-requirements>

Winkler, M. A. (2022, October 25). California Poised to Overtake Germany as World's No. 4 Economy. Bloomberg.com. <https://www.bloomberg.com/opinion/articles/2022-10-24/california-poised-to-overtake-germany-as-world-s-no-4-economy>

## LIFE AS AN ANCESTOR

RICHARD PHAM



---

*WRITER'S COMMENT: When asked to narrate a piece of family history and examine it in a larger social context, I thought of a few figures before settling on my maternal grandfather because I knew little about him. I interviewed my parents, extending my knowledge on the Việt Nam War, as well as his life before legal documents saw him as a Vietnamese American immigrant. UWP 101 began as a simple prerequisite, but it enhanced my ability to tell a narrative beyond the research papers I normally wrote as a political science student. This essay represents a quarter of honing and applying what I learned to create a reader-centric experience, writing not to check marks on criteria but to lay down my voice and fulfill a genuine desire to tell my grandfather's story. With the passing of my maternal grandmother on December 24th, 2022, this essay means so much more to me now.*

*Instructor's Comment: Richard's consistently fascinating essay about his grandfather responds to a family history essay assignment that asks students to write about a family member in relation to a larger socio-cultural and historical context. The best responses—and Richard's essay is certainly among the very best—read as though there was never an assignment in the first place. In other words, Richard has something to say, and what emerges is a captivating, deeply moving investigation and reflection that I'll be using in years to come as a model for other students to follow. Taking us across decades from the Vietnamese island of Phu Quy to his grandfather's eventual emigration to San Jose, Richard deftly achieves intimacy amidst a wide historical context. I especially admire how Richard uses research in*

*a way that allows him to imagine his way into the life of a man he never met—Richard was born a year after his grandfather's death—and an era he never experienced. Richard roots his sweeping narrative in vivid detail and especially well-chosen moments, culminating in a wedding and a moving discovery of an aunt who died young. It's a rich, immersive essay about dignity and loss—and hope.*

*-Greg Miller, University Writing Program*

Born on May 7th, 1938 in the coastal fishing town of Mũi Né, Châu Văn Phạm's first loss was his siblings' premature deaths. The eldest of seven brothers and sisters, only one brother and two sisters would make it to adulthood—the remaining three passed before he learned their names. He knew neither of the Second World War that began a year after his birth, nor colonial rule under the French Indochina that erupted into hellfire between the Việt Nam Quốc Dân Đảng socialist nationalists, Imperial Japanese Army, and Chinese Communist armed forces. Life in Mũi Né meant fishing. Spherical thuyền thúng basket boats mingled along the hot yellow shore, storing bamboo paddles and nets. If he was not planting rice and corn with his mother, Châu Văn Phạm would ride along with his father and uncles on them. On warm days off in the summer of '45, he enjoyed laying on the beach under palm trees, or surveying the fruit and fish markets a two-minute walk away inland alongside friends and siblings.

From teaching the local kids in 1953, to becoming the police chief of a small island named Phú Quý, to marrying Võ Phạm, and to obtaining a health inspector job from her brother who worked for the encompassing Bình Thuận Province by 1955, little changed about him. No one could make him take a bribe, whether a small-time thief or a corporate boss tried to dodge a punishment. Be it gold or hào, he didn't accept a single piece under the principle of phẩm giá: dignity.

But no matter how such dignity conjured love and respect from the townspeople and co-workers around him, the fall of 1955 arrived with the Việt Nam War when communist and anti-communist ideologies clashed amidst the Cold War. And, among the nameless killed and nameless displaced, both of his sisters died early on in the conflict. Hồ Chí Minh's Việt Cộng revolutionaries promptly targeted seventeen-year-old Châu for his government ties, abducting him into a forested re-education camp. To get enriched in an ideal stateless utopia, they had him plant rice and corn at the barrel end of Arisaka rifles. If not strapped to a tiger chair and spat at when asking if his wife and children remained unharmed, he laid in cramped, uncleaned cells beneath the scorching *lương* bamboo stalks outside. Rage and confusion enticed him to fight back, but he complied. He didn't want his family to lose him.

Smear campaigns did not work against the Phú Quý islanders who begged for his release. Months of persuasion had him out in six months. However, the communists relocated the whole family from Mũi Né to Thanh Hóa, a rural forest in the middle of North Việt Nam. Feeling their shared suffering, he took to planting the same crops and constructing a house out of mud walls and a birch tree leaf roof to support eight children. Võ sold the grains and whatever trinkets she made in a nearby market to make commission and buy food. My mother, *Phương*, and my uncles and aunts would participate by selling matches on the dirt streets.

The Lunar New Year did not crackle with strings of tiny red fireworks and mooncakes gifted to one's neighbors, but with gunshots from guerilla warfare— totaling seven thousand civilians killed and seventy-five homes defiled. The 1968 Tết Offensive by the United States provided his brother, Em, an opportunity to escape. A boat person, he fled to the Philippines, immigrated to America, found a job in California, and started sending U.S. dollars to Châu in 1978. The aid allowed him to expand the house, affording brick walls and tiled roofs. The communists let him get the money; they claimed to behave so out of generosity. Even at the war's conclusion in 1975, he did not move back to Mũi

Né—wherever his children could get an education and find jobs mattered more than his hometown, and his reputation as a South Vietnamese military veteran offered trouble or prestige depending on who he talked to. Though most of Thanh Hóa had been bombed and had napalm swept through its jungles, two decades of rebuilding transformed the rural region into a bustling urban center. Indeed, the now Socialist Republic of Việt Nam held the same beachfronts and straw-hatted fishermen selling their catch on the seaside. Despite the broad, nationwide scars, Mũi Né remained unscathed. He may have grown from a four foot child to above six foot, but those palm trees provided the same shade and wonderful awe. The rice paddies he saw while commuting to Hồ Chí Minh City, lined in perfect horizontal tufts of grass and grain poking upright from the light brown waters, appeared no different than the ones he helped his mother with, as well as the ones the Việt Cộng had him excavate. Every Tết, from 1976 to 1992, blossomed once again with lion dances and boisterous firecrackers. Yet, assistance from his remaining brother gave Châu another path. Hope of the South Vietnamese government recovering faded with the United States' withdrawal into other proxy wars. He only had his wife, brother, and children to call family after losing all the others. The war did not kill him—but it killed his Việt Nam, because Hồ Chí Minh City was Sài Gòn.

They emigrated to America in 1993 by plane, partly thanks to Congress implementing the American Homecoming Act in 1989, getting by with social security, Em's knowledge, and minimum wage jobs in San José. Châu Văn Phạm's dignity became fulfilling whatever aspirations his children had in this foreign country; though fifty-five-years-old, the dedication to start from zero and learn English landed him a postal service job driving a mail truck. My mother wanted to join the pharmaceutical industry, so she attended De Anza Community College. There, she met my father, Dao Phạm.

"He was a very serious, nice person. He was quiet, too. But he was a good person. He never complained," my father said. As war

veterans, they bonded over their losses. When he proposed to my mother in 1997, he went to their house and requested both Châu and Võ's approval while serving tea per the traditional Vietnamese ceremony.



On the happiest day of their lives, my parents hired a photographer to compile everything into a two-hour-long DVD video. I had only seen Châu in photographs above our glossy wooden shrine honoring him, my other grandparents, and Buddha. Thanks to this video, I saw his six-foot stature, trimmed and slicked back black hair, and angular, sharp facial features. He spoke in a gentle tone—thin yet grounded enough to render the whole room still while he blessed my father, gave him money, and wished for their prosperity. As the first of her siblings to get married, my mother knew all of his losses. She knew what it took for him to let go of his deceased siblings, let go of Mũi Né, let go of his own mother and father, and let go of her in the hopes she could pass on his dignity. Terminally ill with cancer, Châu simply wanted happiness for his children.

Born on May 21st, 1998 in the diverse city of San José, he showered Jessica Phạm with love. Soon after, William Phạm entered the world in 2000. Having been sick throughout 1998 and 2001 to the point where he permanently sat on a wheelchair, his now-growing family brought him to Paris and Việt Nam to see a



world of peacetime as a way to look past the decades-old trauma from a war that did not end within him. He felt starstruck seeing the Eiffel Tower, and filled with glee to revisit Mũi Né's beaches. These week-long vacations had to end after doctors recommended he stay bedridden in Santa Clara Valley Medical Center, so they listened but made sure to check up on him weekly.

In early 2001, my mother told him she had one more child coming. If biologically male, they'd name him Richard. He felt delighted. In fact, he wanted to see me and at least cradle me before he passed. Regardless of whether he lived or died, he reminded my mother that he remained proud of all they'd done and all they would do.



So she prayed, they all prayed, that he would live to see my birth. On the morning of July 4th, my uncle called her and said Châu did not feel well. On the night of July 4th, he passed away. I would come a year later on April 25th, 2002.

My mother showed me an image from about a year ago: his tombstone. I recognized another tombstone in front of his—my aunt, Lê Bảo Yến. She drowned in 2008, only twenty-three-years old. My parents left my brother and I home on the day of the

funeral, only taking my sister. I didn't understand the back-and-forth hushed phone calls or silent dinner prior. But now I do. I don't know my grandfather, or any of my grandparents except my maternal grandmother. The scarce memories I have about my aunt and grandparents makes our connections murky. They passed before 2002. Still, through the memories of those who cherished them, they live on. For the family I have—and for the family that has already passed on—I respect and love them, without a doubt.

## References

Interview with Phương Phạm, Dao Phạm, and Võ Phạm

Kaiser, Robert G. "Surviving Communist 'Reeducation Camp.'" *The Washington Post*, March 15, 1994. <https://www.washingtonpost.com/archive/politics/1994/05/15/surviving-communist-reeducation-camp/5f6164e7-6370-4d19-95e3-5f10bc66fab0/>

"Tet Offensive: Turning Point in Vietnam War." *The New York Times*, January 31, 1988. <https://www.nytimes.com/1988/01/31/world/tet-offensive-turning-point-in-vietnam-war.html>

"The Formation of French Indochina." *Pacific Atrocities Education*, September 16, 2019. <https://www.pacificatrocities.org/blog/the-formation-of-french-indochina>

"US Involvement in the Vietnam War: The Tet Offensive, 1968." Office of the Historian. United States Department of State. <https://history.state.gov/milestones/1961-1968/tet>

"Vietnam War: 30 Years Later." *The Center for American Progress*, April 29, 2005. <https://www.americanprogress.org/article/vietnam-war-30-years-later/>

SEX, POWER, AND GLITTER: THE  
NIGHTS I DON'T REMEMBER, THE  
NIGHTS I CAN'T FORGET

ANNIE MIYADI



---

*WRITER'S COMMENT: Our midterm in AHI 185: Avant-Gardism and its Aftermath, 1917-1960 involved an unconventional visit to one of my favorite places on campus: the Manetti Shrem Museum. Tasked with writing an exhibition review, an analysis of a specific work, and contextualizing both within the context of the avant-garde, I was eager to formally discuss a place which has been an inspiration to me. Many art history classes focus on reiterating content taught in lecture, but this was an opportunity to apply visual analysis, intersectional knowledge, and contextual understanding to instead draw our own conclusions about a piece. Equipped with a pencil, sketchbook, and exhilarating course concepts, this midterm paper was a joy to write.*

*Instructor's Comment: The midterm assignment in my avant-gardism course was centered around a visit to—and review of—an exhibition at the Manetti Shrem Museum. Annie tantalizes the reader immediately with her title, enticing us not only to read her review but also to go see the artworks that inspired it. After the colon, we are given the equally enigmatic title of the Arcmanoro Niles' painting, upon which Annie would bestow her careful attention. (Niles' looming, yet intimate, scene seemed to radiate a neon warmth on this very cold and very early fall morning.) The unique perspective, rigorous description, and endearing frankness promised by Annie's title are fulfilled by the essay itself, which is comprised of nuanced interpretation and genuinely thrilling turns of analysis. When Annie reminds us*

*that “Blackness is not a monolith,” she succinctly describes the visual diversity of the exhibition within a history of art that is sexy, subversive, and yes, glittery.*

*-Lindsay Riordan, Lecturer in Art History*

The Manetti Shrem museum’s exhibition *Young, Gifted and Black* is a powerful and pertinent showcase of work done by the rising generation of Black artists. The body of work shown reflects the notion that Blackness is anything but a monolith. The breadth of approaches in portraying the Black experience—from Kara Walker’s renowned and disturbing silhouette work to Kerry James Marshall’s proud and icon-like *Den Mother* portrait—show artists connected in heritage and subject, but diverse in a half dozen other aspects. The exhibition’s groupings seek to juxtapose works with similar throughlines together, inviting comparison between one piece and its neighbor, and between one thematic room and the next. Colorful, monumentally sized paintings (*Ghost Leviathan*, *Radiant Sunshine*, *the Morning After [for Lula]*) are in the first room, making a dramatic and impactful entry to the exhibition. The next-largest room is at the far end of the hall, divided between works focused on the black in Blackness (*Gumby Nation*) and experiments with materiality (*Untitled [Three Fencing Masks]*). The smallest room has photography (*The Lovers*), photo montage (*Dematerialization*), and the exhibition’s one video work (*Reifying Desire 5*).

But the work I have been continually drawn to is Arcmanoro Niles's painting *The Nights I Don't Remember, the Nights I Can't Forget*, a super-sized oil, acrylic, and glitter piece from 2018 (Courtesy of the Lumpkin-Boccuzzi Family Collection of Contemporary Art).



At a towering hot pink 6 feet (closer to 8 ½ if the mounting is included) it arrests and confronts the eye. A Black woman with a glittery pink afro sits on a lavender mattress, staring directly at the viewer. Below on an ornately patterned rug, a Black man stares up adoringly at her, modesty protected via a tastefully draped neon orange sheet that matches his neon orange nipples.

Nile's painting is a piece of portraiture which is proudly Black, reflecting intersectional themes of gender roles, power dynamics, superstition, and history while simultaneously remaining fresh and



contemporary. The hair of both figures is vibrantly, unmistakably Black. The hot pink glitter used is arresting, literally and figuratively highlighting a beautiful and undervalued and controversial part of Blackness.

Though this piece can be interpreted as a subversion of Rohypnol-laced date rape with the woman in control instead of the man, this blinkers potential explorations of other themes embedded within. In the context of the exhibition, the narrative of *The Nights I Don't Remember, the Nights I Can't Forget* can be more strongly read as a play on the stereotype of the witch doctor or voodoo priestess. On the left hand nightstand, a female doll with an afro makes eye contact with the viewer while appearing to be performing surgery on a prone male doll. The frightening orange light in the female doll's jack-o-lantern eyes mirror that of the totally orange eyes of the man on the floor, as he gazes adoringly and reaches up towards the woman. He may be a thrall, caught under her spell. This posits an interesting confrontation between racial and gendered stereotypes, about power and control through the lens of the occult.

*The Nights I Don't Remember, the Nights I Can't Forget* is an avant-garde work. Though it appears to adhere, at least to a degree, to the tenets of classic portraiture, the piece is too self-aware, too vulgar and confrontational, and simply too glittery to be considered rear-guard. What separates a conventional work from the avant-garde is a self-conscious awareness of the past paired with a subversion of established norms. Historically, monumental-sized portraits were reserved for nobility. The fact that this is a painting of two fairly ordinary Black people is already a step towards subversion.





*Olympia*, Manet 1865(Folland)



Furthermore, Niles takes the concepts begun in Manet's 1865 early avant-garde oil painting *Olympia* (which itself was a subversion of Titian's *Venus of Urbino*) and pushes them further in new controversial ways. In *Olympia*, a nude white sex worker reclines on a bed while confrontationally staring at the viewer. She is receiving flowers from a Black maid who is rendered almost invisible, nearly indistinguishable from the background (Folland).

In Niles's work, this is turned on its head. A Black woman takes the seat of power. Rather than lounging, she sits upright on the bed exuding a regal solemnity as she confronts the viewer. She is sexually liberated and in control—in the pictogram of intercourse,



she is the recipient of oral and champions a scepter-like arrow above her male lover.

Avant-garde pieces defy “good taste,” and in all honesty, the piece is exceedingly vulgar. At the risk of sounding like an old money Edwardian snob, it could even be classified as gauche. From subservient male nudity to cunnilingus to the jarring hot pinks, oranges, and purples, this work flies in the face of painterly norms. These are taboo subjects paired with gross and confrontational approaches. This “slap in the face of public taste” merges with the artist’s exploration of Blackness. The whole work defies bourgeois preference. White, wealthy, and male art critics who prefer abstraction over naturalism, and those who would seek to make Blackness recede from the public sphere. Through its unabashed vulgarity, *The Nights I Don’t Remember, the Nights I Can’t Forget* proudly presents Blackness, sexuality, and femininity as a force to be reckoned with.

The exhibition *Young, Gifted and Black* is a fascinating collection of diverse, contradictory, and powerful works. There are blue chip artists and rising stars, photographers, painters, sculptors, and textile workers. This is a particularly tumultuous time to be a person of color, and national assumptions over race and institutional power are being questioned. It is more important than ever to have conversations about Blackness, to experience other points of view, and to develop empathy for others’ lived experiences. I believe that this exhibition is an excellent example of an institution attempting to facilitate these connections. No matter who you are, you can find a piece which resonates with you at this exhibition and I would highly recommend visiting it.

## **Works Cited**

Folland, T. Edouard Manet, Olympia, 1865. Retrieved from

<https://www.khanacademy.org/humanities/becoming-modern/avant-garde-france/realism/a/manet-olympia>.

Niles, Arcmanoro, The Nights I Don't Remember, The Nights I Can't Forget, 2018. Courtesy of the Lumpkin-Boccuzzi Family Collection of Contemporary Art.

PAVING THE WAY FOR EQUALITY: THE  
EARLY CIVIL RIGHTS MOVEMENT  
AND THE FIGHT AGAINST HOUSING  
DISCRIMINATION IN CALIFORNIA

SAMANTHA VANPELT



---

*WRITER'S COMMENT: Growing up a military kid made moving second nature to me. So when Professor Louis Warren asked us to write a paper about modern California history, I immediately gravitated to the migrations spurred by defense contracting during World War II. One of the major focuses in the seminar was the idea of the California Dream and the often-thwarted search for it. This constant striving reminded me of the equally elusive American Dream. Focusing on Black Americans' wartime migrations to the Bay Area gave me the opportunity to study this hunt for the Dream within the larger, national fight for civil rights. Despite California's professed openness, Black Americans struggled to find peace and equality in the Golden State. This struggle even touched their basic need for housing, which I decided to focus on and use as a lens through which to analyze the long fight for civil rights during the war and the larger movement of the 1960s it led to.*

*Instructor's Comment: Samantha Van Pelt produced this prize-winning essay for my history seminar in winter, 2023. Samantha elected to do a paper on the Black struggle for equal housing in California in the middle third of the twentieth century. This is a striking topic, but not because this period saw enormous success in the equal housing fight. Rather, as Samantha's essay shows, the period's few victories were punctuated with appalling episodes of anti-Black intimidation and violence. This artfully written, carefully researched paper succeeds because it shows the gritty, relentless political battles that Black residents waged merely to create a foundation for the larger victories*

*that followed only in the later 1960s. Samantha Van Pelt's economy of language and poetic understatement combine to produce not only a crisp, concise essay, but a moving history of social struggle.*

*-Louis S. Warren, Department of History*

Nathan G. Tademý Jr. was a United States Navy veteran living with his family in Oakland, California in 1947. After returning from service less than a year ago, Tademý was excited to reconnect with his wife and three children and, after securing the nation from the Axis threat, begin building a stable and happy life in the Golden State. While his family lived in one of the federal housing complexes for migrant workers during the war, Tademý and his wife earnestly sought a home in which to put down true roots and raise their young children. They found just that in a house on Burnette Street, and with help from a GI loan, they quickly moved in. That was September. By the end of November, Tademý found himself holding a court summons, served by twelve neighboring families, declaring that he had violated the area's restrictive racial covenant. Despite risking his life to protect his nation and defeat racist discrimination abroad, Tademý and his family—a Black family—received a clear reminder that the win overseas did not translate into a win in their home country.<sup>1</sup>

When thinking of the fight for civil rights in the United States, the movement of the 1960s is undoubtedly the first to come to mind. However, the fight for equality in this nation has a long history, and though the most famous fight played out in the sixties, the seeds of it were planted long before. From 1940 to 1946, an

---

<sup>1</sup> "Whites Seek To Oust Vet And Family From Home," *The Chicago Defender*, January 11, 1947, <https://www.proquest.com/bsc/docview/492728464/9B99D195FA45426APQ/5?accountid=14505&parentSessionId=hS6houQWVjdtPHwvWCxiztDtFFfNyBUWHOHHDCk4BDE%3D>.

estimated three million left the South for “greener pastures,” and while the numbers did not get into demographic information, many of those leaving were Black and heading for the West Coast.<sup>2</sup>

With a wealth of war contracts and war industry jobs up for grabs, Black Americans hoped to find steady work while carving out a new life for themselves and their families.<sup>3</sup> But the West Coast, and California specifically, only brought the same old challenges in new locales. Even when fighting racism abroad and proving themselves loyal citizens at home, Black Californians faced the same discrimination they fought to end overseas through restrictive housing covenants and outright animosity. The battle for acceptance in their new homes reflected the larger, national fight for equality regardless of color or race, a fight that would fully erupt in the 1960s.

Black Americans were not the only ones drawn to California and the Bay Area during the war. Though many people sought work in the war industry, active-duty military members moved their families to the coast to be ready for deployment while many residents of the Hawaiian Islands and other Pacific outposts came to the mainland to avoid the conflict.<sup>4</sup> Despite being one of the largest states in the Union, the sudden influx of people to areas already densely populated revealed the stark realities of northern California’s housing shortage.<sup>5</sup>

The need for inexpensive housing was already well documented and acknowledged before the war. In 1934 President Franklin D. Roosevelt passed the National Housing Act that created the Federal

---

2 “3 Million Trek From South From ’40 to ’46,” *Los Angeles Sentinel*, September 11, 1947, <https://www.proquest.com/hnplsentinel/docview/562098860/2679C321BC8445F0PQ/20?accountid=14505>.

3 Lewis Reynolds, “California’s Boom: War Brings Biggest Mass Migration Since the Gold Rush of 1849,” *Wall Street Journal*, November 10, 1942, 1, <https://www.proquest.com/hnpcaliforniacollection/docview/131401910/8BB2FF436BAB43C6PQ/10?accountid=14505>.

4 Ibid.

5 Ibid.

Housing Administration (FHA), which encouraged building new homes and repairing existing ones. <sup>6</sup>With new housing struggles on the rise, and especially for wartime migrants, President Roosevelt established the National Housing Agency (NHA) in 1942, recruiting the private sector to help house defense workers. <sup>7</sup>Through the NHA, the war guest program encouraged local homeowners in the Bay Area and across the nation to open their homes to migrants as tenants and boarders. <sup>8</sup>

Though the plan did little to address the root issue of the problem—the fact that there simply were not enough houses in the area—it did create some opportunity for migrants and homeowners alike. The potential for extra income was an alluring incentive to many established Bay Area residents, especially single women and widows. <sup>9</sup>The issue here, unfortunately, was that most of the people willing to take on boarders were themselves struggling. Bay Area residents in the middle- and upper-classes were wary of bringing strangers into their homes, and landlords in higher-rent districts (where the larger homes undoubtedly were) resisted renting to war migrants, claiming that they “damaged homes and property.”<sup>10</sup> The population surge to the San Francisco Bay Area left local vacancies at “less than [half] of 1%.”<sup>11</sup> Including single rooms for rent in private homes, the figure increased to 3%, while in Oakland, where most of the industrial plants and workers resided, the numbers were even worse at a striking 1% vacancies.<sup>12</sup> Would-be renters filled local newspapers with “[pleas] for houses or apartments.” <sup>13</sup>

---

6 “FDR and Housing Legislation,” Franklin D. Roosevelt Presidential Library and Museum, accessed March 4, 2023, <https://www.fdrlibrary.org/housing>.

7 Marilyn S. Johnson, *The Second Gold Rush: Oakland and the East Bay in World War II* (Berkeley: University of California Press, 1993), 87-88.

8 Ibid, 88.

9 Ibid, 89.

10 Ibid, 90.

11 Reynolds, “California’s Boom,” 2.

12 Ibid.

13 Ibid.

In this atmosphere, it was not uncommon to see migrants and their families living on the streets.<sup>14</sup>

With so many new people arriving, all with different backgrounds and experiences, and a war raging, stress was undoubtedly high. Moving across the country was no small feat, and after the attack on Pearl Harbor, the West Coast was on high alert. At a time when the state—and the larger nation—needed people to come together, both took actions that deepened rifts rather than bridging them. The struggle to find housing in the Bay Area made newcomers desperate, driving them to beg and scrape for limited housing. This struggle was even worse for Black migrants, who found their search for shelter further limited by the same racism they had hoped to escape.

After the presidential election in 1936, wherein Black Americans made an unprecedented shift to back the Democratic candidate, many hoped Roosevelt would work to bring about racial justice and equal civil rights.<sup>15</sup> In his first term, New Deal programs helped alleviate many of the effects of the Depression while creating various social safety nets. These programs seemed to cement Roosevelt as a leader invested in helping the common man. However, the early New Deal had largely been “[indifferent] to the needs of Black Americans,” something Black Americans hoped would change in Roosevelt’s second term.<sup>16</sup> By supporting Roosevelt, they hoped he would in turn support them.

When Black Americans needed housing, then, they looked to Roosevelt’s administration. They turned to the newly created National Housing Agency and the older Federal Housing Administration to secure housing in the congested Bay Area. Their hopes, though, were quickly dashed. Even before the war, the FHA had showcased a strong preference for funding “all-white suburban

---

14 Johnson, *The Second Gold Rush*, 84.

15 Martha S. Jones, *Vanguard: How Black Women Broke Barriers, Won the Vote, and Insisted on Equality for All* (New York: Basic Books, 2020), 204.

16 Ibid, 205.

housing,” and this preference only grew once the war began.<sup>17</sup> Rather than helping wartime migrants in the heart of defense cities, FHA money went to subdivisions restricted to those “wholly of the Caucasian race,” an edict that shut down any hopes for agency support that Black Americans had.<sup>18</sup> The war guest program under the NHA was equally tight-fisted when it came to assisting Black migrants. Though the program encouraged and offered incentives to local homeowners, Black migrants were limited to searching for homes in the same neighborhoods where “old-timers” to the area lived.<sup>19</sup> These areas, specifically west Oakland and north Richmond, were already as densely populated as the rest of the Bay Area. About 8,500 Black Americans called Oakland home in 1940.<sup>20</sup> Richmond’s total population numbered 23,642.<sup>21</sup>

Still, established Black homeowners opened their doors to new arrivals. To make room they subdivided large Victorian homes and took in kin that arrived due to chain migration.<sup>22</sup> Over the course of the war, the population density of north Richmond and west Oakland exploded. Before the war, the percentage of overcrowded Black households in west Oakland and north Richmond were 15.2% and 8.1% respectively; by 1950, those percentages had climbed to 30.7% and 56.1%.<sup>23</sup> By refusing to assist all war migrants equally, federal and state housing programs made already tight areas even tighter, undoubtedly heightening stress levels for everyone as old and new families sought to carve out space for themselves.

---

17 Johnson, *The Second Gold Rush*, 92.

18 Ibid.

19 Ibid, 93.

20 “City of Oakland, Alameda County,” Bay Area Census, accessed March 13, 2023, <http://www.bayareacensus.ca.gov/cities/Oakland40.htm>.

21 “City of Richmond, Contra Costa County,” Bay Area Census, accessed March 13, 2023, <http://www.bayareacensus.ca.gov/cities/Richmond50.htm#1940>.

22 Johnson, *The Second Gold Rush*, 93.

23 Ibid.



When government programs did create temporary housing open to Black migrants, it was often so poorly made that it increased rather than diminished problems. In the rush to house incoming war employees quickly and cheaply, the federal government frequently cut necessary corners. Many temporary units were poorly designed and overlooked basic safety measures.<sup>24</sup> The locations of these projects—often on landfill sites next to railways, beside industrial facilities, and directly on the waterfront—created additional problems, as they were hotspots for both natural and health disasters.<sup>25</sup> Polio, tuberculosis, and influenza outbreaks were as common as floods, and the mosquitoes the water attracted likely brought further illness.<sup>26</sup> In approving the creation and use of these projects, federal and local governments made it clear they had little interest in the quality of the lives of the migrants they targeted and drew to their cities. The lack of urgency to fix these well-documented issues served as a silent seal of approval. While they wanted Black migrants' labor, they did not want them getting too comfortable in the Bay Area.

Despite the clear forces against them, Black migrants refused to have their rights as state residents and Americans curtailed. Part of California's draw was the idea that discrimination was less entrenched than it was in the South. And in some ways, it was better. However, Black Americans were not content with simply better treatment; they wanted fair and equal treatment. As the injustices against them grew, Black migrants and old-timers banded together to fight for their rights.

Like the Bay Area, Los Angeles was riddled with restrictive housing covenants that confined Black residents to certain, condensed areas. When a group of Black aristocrats, including actresses Hattie McDaniel and Louise Beavers and singer Ethel Waters, moved into Sugar Hill neighborhood, eight white neighbors

---

24 Ibid, 109.

25 Ibid, 108.

26 Ibid, 108-109.

went to the courts looking to oust them. The Black residents met them there, bringing their money, a large group, and their name recognition. When the case came before Judge Thurmond Clarke in December of 1945, he dismissed the covenants and cited the 14th Amendment to uphold his decision. Going a step further, Clarke condemned his fellow judges' silence on the housing issue. Still, the Sugar Hill victory was short-lived. In response to Clarke's decision, many California real-estate organizations pushed to amend the U.S. Constitution and keep discriminative practices in place in the name of protecting American families. When that failed, they looked to the state constitution.<sup>27</sup> That particular fight peaked with two-thirds of California voters repealing the Rumford Fair Housing Act in 1964, a short-lived—the U.S. Supreme Court invalidated the decision by invoking the 14th—but telling victory.<sup>28</sup>

A few days after the success in Sugar Hill, however, O'Day Short lost his wife and kids when his Fontana home burned in “a fire of unknown origin.” Suffering third-degree burns in the hospital, Short relayed his earlier reports of threats against his family to a *Los Angeles Sentinel* representative. In answer to his reports, two deputy sheriffs visited him at home and informed him of his neighbors' complaints regarding “his presence on his own property.” Shortly after the visit, the fire broke out. It was a clear example of the city's public defenders failing to defend the public they served. O'Day Short eventually succumbed to his injuries, but the *Los Angeles Sentinel* and Black Americans continued to push for justice.<sup>29</sup>

---

27 Patt Morrison, “Behind the new show ‘Them’ is the ugly and true history of L.A.’s racist housing covenants,” *Los Angeles Times*, April 27, 2021, <https://www.latimes.com/california/story/2021-04-27/behind-a-new-tv-show-is-the-ugly-and-true-history-of-l-a-s-racist-housing-covenants>.

28 David Wyatt, *Five Fires: Race, Catastrophe, and the Shaping of California* (New York: Oxford University Press, 1997), 211.

29 “Violence Threat Against Short Must Not Go Unchallenged,” *Los Angeles Sentinel*, January 3, 1946, <https://www.proquest.com/hnplasinetel/docview/562095430/10D82BAA6614121PQ/3?accountid=14505&parentSessionId=gV9JslYJcDBOuZ6%2BwQd9KXsWM8afEA2DDI4z9UKr1bo%3D>.

To strengthen their fight, Black Californians turned to the National Association for the Advancement of Colored People (NAACP) and the organization's lawyers. Justice, both widespread and individually based, seemed within reach when the NAACP took up Short's case and turned it over to the California Grand Jury and, later, to the Los Angeles branch of the FBI.<sup>30</sup> Soon after, local and national NAACP offices began bringing restrictive housing covenants to court across the nation. In five cases across Missouri, Michigan, Ohio, California, and Illinois, the organization's lawyers sought "showdown ruling[s]" on the validity of discriminative housing practices.<sup>31</sup> By bringing the NAACP into the fight, Black Californians, and Black Americans across the nation, asserted their determination to achieve equal treatment everywhere in the United States. In coming together both locally and nationally, they were amassing a united front in the long-running war for civil rights. They were forging a movement.

World War II and the wartime migrations it sparked further proved to Black Americans that while the nation expected much from them, they could expect very little in return. Though they had helped land Franklin Roosevelt in the White House for four terms, the President offered very little in the way of thanks. Instead of helping its newest constituents find housing, the Roosevelt administration left them to largely fend for themselves. Rather than working to pass civil rights legislation to ensure all defense migrants were treated humanely in their new workplaces and cities, the administration enlisted local help without sparing a thought toward local prejudices. These patterns of halfhearted assistance

---

30 "O.H. Short 4th Fontana Victim Dies: Lacked Interest in Recovery," *Los Angeles Sentinel*, January 24, 1946, 2, <https://www.proquest.com/hnplatimes/docview/562081865/E88737E8FE8A4AFDPQ/2?accountid=14505>.

31 "Restrictive Covenant Cases to High Court: All-Out Fight on Zone Laws Started," *The Pittsburgh Courier*, January 24, 1947, 1, <https://www.proquest.com/hnpittsburghcourier/docview/202217549/38EE82DBBBB641BAPQ/2?accountid=14505>.

left established and newly arrived Black families on the fringes of American society even as the nation tried to present a united and prosperous front to the rest of the world. The shreds of assistance federal and local governments offered highlighted a joint desire to see certain populations flourish while leaving others to wilt.

In the face of this adversity, Black Americans resolved to help themselves. The end of the war brought soldiers like Nathan Tadey Jr. home to the same issues they fought overseas and had been fighting since the nation's inception. Even after valiantly fighting for the United States, Black soldiers returned to find their home nation still at war with them because of the color of their skin. Rather than accept what little comfort they could carve out for themselves, Tadey and other Black Americans made it their mission to achieve equality in housing and all aspects of life.

A year after Tadey's case, and many others like it, the U.S. Supreme Court ruled in 1948's *Shelley v. Kraemer* that restrictive housing covenants were illegal. As Judge Clarke did three years earlier, they cited the 14th Amendment as the legal basis. Though the success enshrined the idea of equality in housing, it did little to change things on the ground. Housing discrimination, as well as general discrimination, continued to plague the lived experience of Black Americans. But in bringing their cases to court and joining together to help one another, they made it clear that the abuse heaped on previous centuries of abuse would no longer be silently borne. These small victories, hard won and immediately targeted, paved the way for the 1960s movement to fully bloom. In these early fights, Black Americans declared their intention to not only survive, but to thrive.

## THE WEIGHT OF MY WORDS

NKAUJ HMOOB VUE



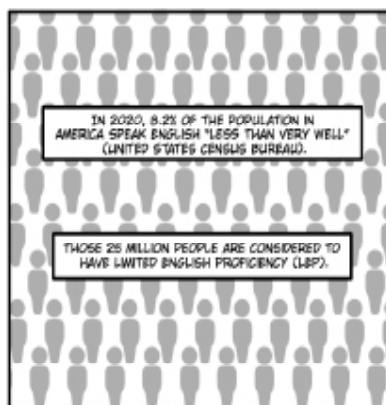
---

*WRITER'S COMMENT: This was actually my second attempt at this assignment. When Dr. Karma Waltonen gave us the opportunity to write our case study in a graphic novel format, I didn't hesitate to make something that let me work with my different passions—healthcare, art, writing, and my Hmong culture. For this case study, we had to explore a theme in health science by integrating a story. This comic narrates a personal experience that I'm sure many other people with immigrant parents or grandparents, who have limited English proficiency, can relate to. I often act as a family interpreter for my mom during clinical visits, and after one particular visit, I was compelled to explore interpreter services in healthcare and its effect on patients. I never realized the significance language has on a patient's healthcare experience until I self-reflected during my research on this topic. Different variables in interpreting have different effects on the patient's experience. This comic specifically gives an insight to the use of family interpreters. I hope you enjoy this short comic and that it'll help bring more awareness to interpreters in healthcare.*

*Instructor's Comment: Students in my Writing in the Professions: Health Science classes create several papers. Often, the most difficult is the case study, in which students must teach a lay audience about a health science issue. They have the option to use a graphic novel format. However, as graphic novel essays take much longer to write than traditional essays and as it's difficult to grapple with a new genre, few students take me up on it. Despite taking the class in the summer (thus having four fewer weeks to work with), Nkauj Hmoob H Vue*

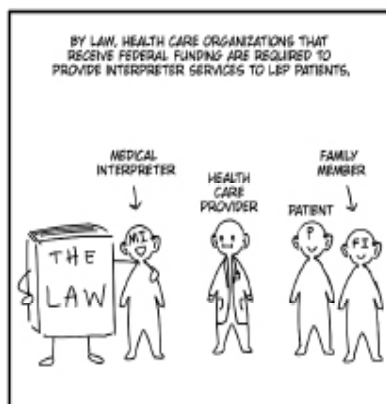
*was more than up for the challenge. Her piece is a moving look at the difficulties faced by families needing translators for health services, including the pressure on children to facilitate their parents' access to health knowledge. Nkauj's drawings are masterful, using expressionist techniques to illustrate mental states and using humor to engage the audience. I'm most impressed by her ability here—in a paper about translation—to translate her case and her research for the audience in this visual form.*

*-Karma Waltonen, University Writing Program*





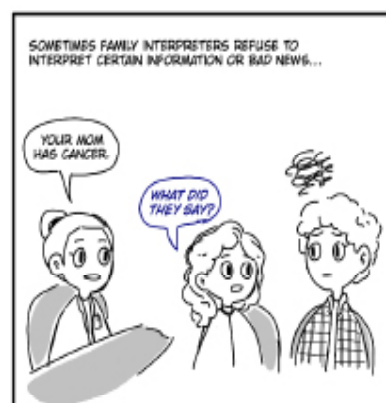
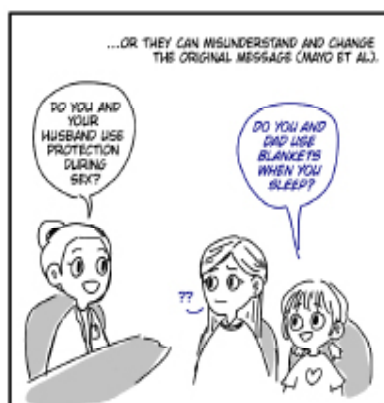
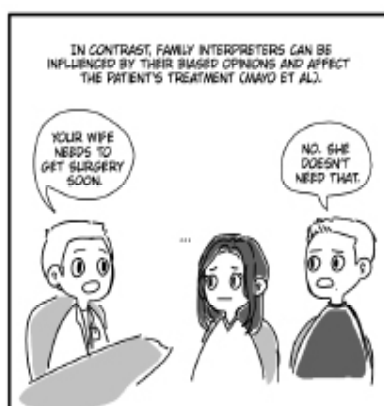
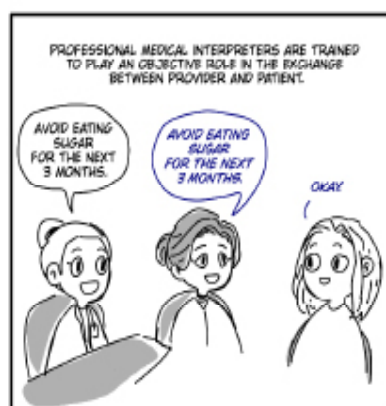


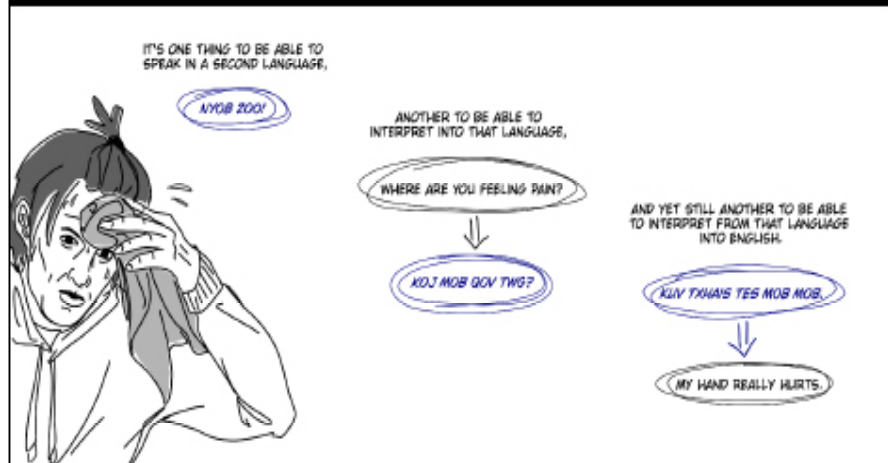
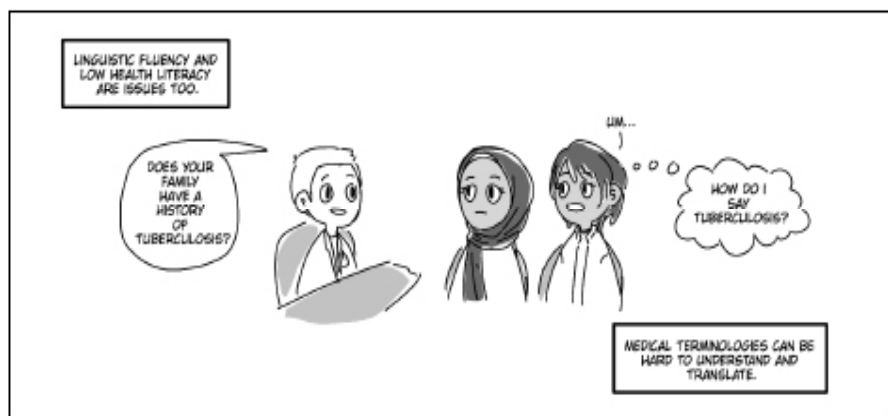


THEY COST NOTHING TO USE:



HOWEVER, THERE ARE MANY PROBLEMS WITH THIS METHOD.





CHILDREN USED AS INTERPRETERS  
ARE A SPECIAL PROBLEM.

DAD, WHAT DOES

CHOLEDOCHOLITHIASIS

MEAN?



\*CHOLEDOCHOLITHIASIS: STONES IN THE GALLBLADDER OR COMMON BILE DUCT

THEY OFTEN FEEL A TREMENDOUS BURDEN OF  
RESPONSIBILITY, EVEN GUILT, FOR THE  
INFORMATION THEY CONVEY.

MOM, THEY  
ASKED IF YOU'VE  
BEEN FEELING  
PAIN AND SLEEPY?



AND JUST AS OFTEN, PARENTS CAN BE EMBARRASSED OR  
RELUCTANT TO TELL IMPORTANT SYMPTOMS  
AND DETAILS TO THEIR CHILD.

...MOM'S NOT IN A  
LOT OF PAIN.  
I'M JUST A LITTLE TIRED  
SOMETIMES.  
DON'T WORRY



MY MOM IS HONG-CHINESE AND IMMIGRATED TO  
AMERICA FROM CHINA AFTER MARRYING MY DAD.

HMOOR, HELP  
YHANS LUS  
RAU KUN!  
(HMOOR, HELP  
TRANSLATE FOR  
ME.)

OKAY!  
COMING!!

EVEN THOUGH SHE'S LIVED IN THE U.S. FOR  
NEARLY 22 YEARS, HER ENGLISH ISN'T VERY FLUENT.

AS THE ELDEST OF SIX KIDS, AND THE MOST FLUENT IN HONGS AMONG  
MY SIBLINGS, I'VE OFTEN HELPED MY MOM WITH INTERPRETING SINCE YOUNG.



YOU WISH  
TO  
SPEAK  
TO MY  
MOTHER?



APPLE  
JUICE

YOUNGER ME  
HAD LONGER  
HAIR



HAAA,  
HOW CUTE.  
HOW OLD  
ARE YOU?

IT BECAME A RESPONSIBILITY, OBLIGATION,  
AND EXPECTATION FOR ME AS A DAUGHTER.



HOWEVER, THERE ARE TIMES WHERE I FEEL INSECURE,  
DOUBTFUL, AND ASHAMED OF MY LIMITED  
LINGUISTIC ABILITIES.



HOW DO I SAY "CAWS YALIM" IN ENGLISH? WA-  
IT, WHAT DOES "CAWS YALIM" MEAN AGAIN?  
IS IT "NLMB?" WOULD IT BE BETTER TO SAY  
AY "TINGLING?" DID A MAM MEAN "TINGLING?"  
WHAT'S THE WORD FOR "NTSUJ?"  
HOW DO I SAY "BACK" IN HMONG  
AGAIN? WHAT ABOUT "LOWER  
BACK?" I DON'T KNOW. I'LL  
JUST POINT. WHAT WAS "N-  
ECK?" HOW DOES SHE DESCRIBE  
WHAT "LOOG" MEANS AGAIN?  
DOES IT MAKE SENSE IF I SAY IT  
THIS WAY? WHAT IF I SAY IT WR-  
ONG? HOW DO I SAY IT IN ENGLISH? WA-  
AIT, OK, SO MOM SAID THAT  
"NTSUJ" IS LIKE "TENSE," SO IT'D  
BE BETTER TO SAY "TENSE," RIGHT? I'LL JUST  
SAY "TENSE." I HOPE THAT'S THE RIGHT WORD.

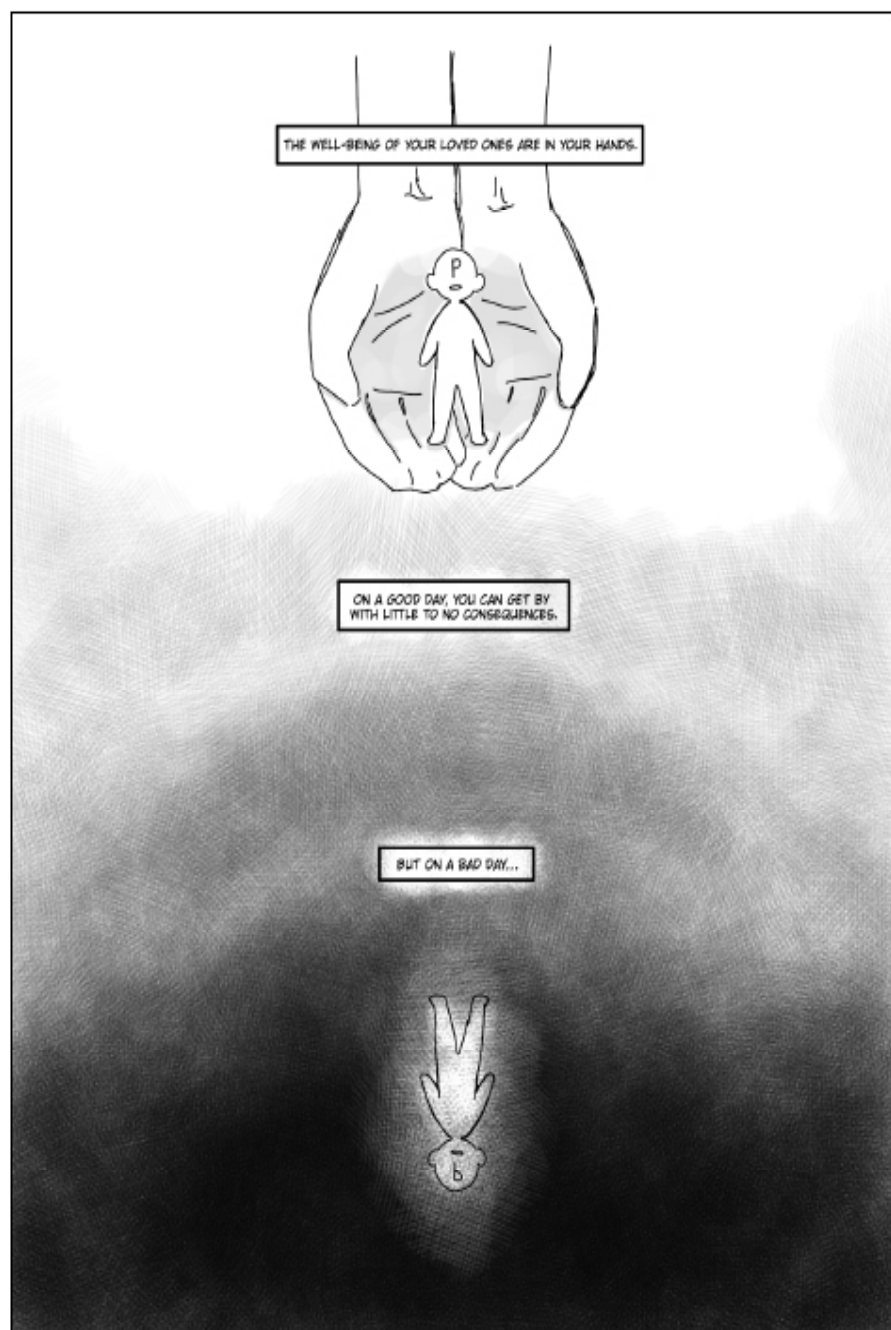


...SHE SAID ~~~~  
~~~~~  
~~~~~



IT MIGHT NOT SEEM LIKE A BIG DEAL WHEN  
INTERPRETING FOR YOUR FAMILY BECOMES YOUR NORM...

...BUT WHEN YOU REALLY STOP TO THINK ABOUT IT,



MY MOM AND I LEFT THE CLINIC THAT DAY DISPLEASED  
AND UNSATISFIED WITH THE CARE THEY PROVIDED.

WE WERE BOTH FRUSTRATED FOR OUR OWN REASONS.

I BROODED OVER MY INTERPRETING SKILLS,  
FEELING LIKE I WAS LACKING.



MY MOM COMPLAINED ABOUT THE DOCTOR,  
FEELING LIKE SHE WASN'T TAKEN SERIOUSLY.



PROFESSIONAL MEDICAL INTERPRETER,  
FAMILY INTERPRETER, OR NO INTERPRETER.



AT THE END OF THE DAY, IT'S THE  
PATIENT WHO'S MOST AFFECTED.



Works Cited

- Diamond, Lisa C., et al. "Getting By: Underuse of Interpreters by Resident Physicians." *Journal of General Internal Medicine : JGIM*, vol. 24, no. 2, 2008, pp. 256–62, <https://doi.org/10.1007/s11606-008-0875-7>.
- Free, C., et al. "Bilingual Young People's Experiences of Interpreting in Primary Care: a Qualitative Study." *British Journal of General Practice*, vol. 53, no. 492, 2003, pp. 530–35.
- Mayo, Rachel, et al. "Cutting Corners: Provider Perceptions of Interpretation Services and Factors Related to Use of an Ad Hoc Interpreter." *Hispanic Health Care International*, vol. 14, no. 2, 2016, pp. 73–80, <https://doi.org/10.1177/1540415316646097>.
- Karliner, Leah S., et al. "Do Professional Interpreters Improve Clinical Care for Patients with Limited English Proficiency? A Systematic Review of the Literature." *Health Services Research*, vol. 42, no. 2, 2007, pp. 727–54, <https://doi.org/10.1111/j.1475-6773.2006.00629.x>.
- Schenker, Yael, et al. "Patterns of Interpreter Use for Hospitalized Patients with Limited English Proficiency." *Journal of General Internal Medicine : JGIM*, vol. 26, no. 7, 2011, pp. 712–17, <https://doi.org/10.1007/s11606-010-1619-z>.
- United States Census Bureau. "Comparative Social Characteristics in the United States." 2020 *American Community Survey 5-year Estimates Comparison Profiles*, <https://data.census.gov/cedsci/table?q=social%20characteristics&tid=ACSCP5Y2020.CP02>. Accessed 17 Aug. 2022.



## FROM NEW COUNTERTOPS TO NEW PHILOSOPHIES AND STRATEGIES OF DESIGN: A WOMAN'S PLACE IN THE KITCHEN

SOPHIE JORCINO



---

*WRITER'S COMMENT: I grew up going to open houses with my family. Every weekend, we would load into the minivan and head to an array of homes, diverse in their design, history, and locations. My parents taught me and my siblings their very precise approach to walking through and rating a home: always start in the kitchen, as this is where the most time would be spent. For my family, and many others, the kitchen is the center of the home. It's where we cook, eat, converse, clean, do homework, ask for advice, hear stories, and come together. Naturally, when Dr. Christina Cogdell assigned this paper on American architecture, I knew I needed to start in the kitchen. The process of examining it from a design, architectural, and feminist perspective took me even beyond the kitchen, and allowed me to focus on certain women who in being socially and culturally limited to the kitchen were able to take control of the space as one that best suited their needs, desires, and culture.*

*Instructor's Comment: AHI 188B History of American Architecture examines US buildings within their social and cultural historical contexts, including issues of race, class, gender, and sexuality. Sophie Jorcino researched and wrote about women's influence on the design of their own spaces in the home, either through kitchen adaptations or, in some remarkable cases, as single patrons hiring architects to design their own home. Madame CJ Walker, a freeborn African American in New York during Reconstruction, became a self-made millionaire whose home, designed by New York's first registered Black architect Vertner Tandy, demonstrates to others Black accumulation of wealth.*

*In the 1950s, Constance Perkins, an Occidental College art history professor, designed her home as a live-work studio, only to have the bank force her to create a separate bedroom in order to receive financing. I love Jorcino's topic and writing, and I love when my students teach me through their research.*

*-Christina Cogdell, Professor, Department of Design*

In a way, the kitchen is the center of the world. In ancient times, communities gathered to eat around the fire where the food was made. It is a room that is meant to aid survival and cater to basic needs. For better or worse, the space is seen as a 'woman's space': one she is in charge of, one she can control, one she is restricted to. In the late 1800s, Catherine Beecher Stowe wrote two handbooks for the modern homemaker: the first, *A Treatise on Domestic Economy*, aimed to standardize the ways women maintained their home. Her second book, *American Woman's Home*, was another instructional guide that is viewed today as one of the most comprehensive looks at what homemaking meant to women in the 1800s. In her books, Beecher created several plans for model homes that exemplified these scientifically and religiously driven values. While never built, her designs show a woman's perspective on how the home should be created. Since Beecher, there have been several examples of the home being reimagined by women to better fit them, many of which have foreshadowed groundbreaking architectural innovations. The world of architecture is one that has been and still is dominated by the ideas and designs of men and is one that largely ignores the kitchen as a space that women have historically had the most authority over. It has been a space where women can experiment and implement new designs, philosophies and technologies. With the kitchen being such a unique space, it only makes sense that many world changing architectural innovations started at the kitchen table and radiated out to the rest of the world.

The home has been seen as one of the few realms that women can fully take control of. In *Outgrowing the Corner of the Kitchen Table*, Ghislaine Hermanuz takes a look into the history and philosophy of the homemaker. Not only is the home a sort of refuge from the outside world, but it is a place where women traditionally have the right to have a direct impact on the space that surrounds them and their family. In occupying a space, we allow ourselves to mold and fit to the unique niches and corners it is built out of and in return, see a change in our own selves. When a woman took up the role of wife or mother, she inadvertently took up the role of home designer and interior architect. Hermanuz's writing takes a deeper look into the concept of 'home' and 'work' spaces- their integration and segregation within the home, and how the organizations of these spaces define how communities work. To view the kitchen through Hermanuz's eyes is to see an example of the colliding of these two spaces: the kitchen represents a space where a woman works and lives, it is a "mythical place where, by force rather than by choice, novels have been written, design competitions have been won, scientific problems have been resolved, while at the same time children's homework is supervised, socks are mended, and meals are prepared." (Hermanuz 67). In examining the plans for homes that Beecher included in her books, the kitchen is seen as a sort of

control room for the rest of the home. Figure 1 shows her plan for the first floor of a cottage. At first glance, the kitchen seems to be tucked away in the back of the house but further examination reveals more purposeful and innovative choices. The kitchen is open on both sides, outletting to both the main rooms. It is

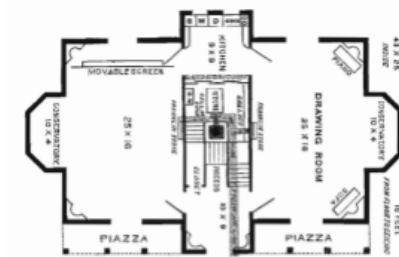


Figure 1: Beecher's plan for ground floor of a model cottage.

simultaneously a transitional, working, and monitoring space for the leader of the home.

In examining a recent history of the arrangement and interpretation of what the kitchen should be, a distinction between the 'kitchen-diner' and the 'work kitchen' is crucial. In the early 1900s, German cities designated different 'kitchen planners' to design their city's standard kitchens. This resulted in regional differences between kitchens: the 'work kitchen' was seen as a functional expression of contemporary architecture while the 'kitchen-diner' was seen as a more traditional space for both domestic work and gathering. The Nazi era ended this growth and adaptation in the kitchen world, but these ideas were taken further in the US, Sweden, and Switzerland. Efficiency was seen as the most important thing in the kitchen, and the size and shape of it was supposed to streamline this. A specific kitchen was created by men to create "a workplace comparable to that of her husband in terms of its function and quality." (Surmann 52) However, women had always carried out the duties associated with the kitchen in the presence of family and children, and this new design separated her from them. This was seen through the moving of eating spaces to realms outside of the kitchen and through the industrial qualities given to the kitchen. During this time, the design style was characterized by stark color contrast and angular shapes, giving the kitchen a cold and unwelcoming futuristic feel. The 1950s saw a reconnection between the home and the kitchen through serving hatches and breakfast bars. This was in part due to the technical, esthetic and social changes. The women in the kitchen at this point had been girls who had not only seen their mothers orient themselves in the cold and sharp kitchen of the 1930s but also through the postwar social and economic change. The main changes to happen in the 1960s and 70s were mostly driven by improvements in ergonomics and hygiene, with later considerations to the social psychology of the kitchen as a gathering space being added. The kitchen was quickly becoming a warmer space. This change was mainly driven by the addition of an eating space within it, though aesthetic change towards warmer colors and rounder shapes aided in this change and today remain some

of the most iconic emblems of the era. The 1980s saw a change in the image of the family with alternative living and partnership organizations which ultimately affected the pleasures found in cooking and eating. People wanted to make more diverse meals and cook in a more social manner. Kitchens were made to be places of decoration and prestige rather than as work spaces. The kitchen moved out of the work space and into the living space through island workstations and the combination of electrical appliances. The 1920s wanted to free women from work that was seen as unnecessary and monotonous while still recognizing the role of the housewife as a valid profession. However, this has not caused kitchens to be streamlined and efficient work environments. The kitchen has gone back to being the heart of the home and as a central focal point for social, family, and household activity.

Although women have an incredible level of control over their home, the actual architecture is usually something that they do not have much control over. In a few rare cases, women have been able to commission and work with architects to build a home that meets their needs. Demands for houses from women are sometimes seen as unconventional for male architects, but their wants have created some of the most innovative and creative homes in the world, such as Frank Lloyd Wright's Olive Hill home for Aline Barnsdall, Le Corbusier's Villa Stein de Monzie, or Mies van der Rohe's Farnsworth house in Plano, Illinois. These homes are often discussed in a way that ignores the woman client's role in their uniqueness and design. As discussed earlier, the kitchen—and therefore the home—of women in the later 20th century showed a movement away from 'traditional' family models and towards more unique and unconventional arrangements: single women, intergenerational housing, same-sex couples and their families, and single parents. In *Shifting the Paradigm: Houses Built for Women* by Alice T. Friedman, this shift is documented: "Homes designed for female heads of households, with and without children, demonstrate a radical shift away from the conventional domestic program and the values and power relations structuring that program: the separation of home

and work; the focus on reproduction in the family and socialization of children; hierarchies based on categories of sex, age, race, class, and servant versus served; focus on the heterosexual family and an overarching embrace of heterosexual privilege.” (Friedman 86). As evidenced in the following case studies, a successful partnership between women clients and male architects creates innovative planning and also brings in technology as a bridge between home and work.

The first case study is the home of Madame CJ Walker, the first female self-made millionaire and woman behind a hair-care empire that took advantage of a direct-to-customer selling strategy that prefigured that of the Avon Ladies and the at-home Tupperware parties. She worked with architect Vertner Woodson Tandy to design her home. A large and impressive white walled mansion, Villa Lewaro is an example of the American Beaux arts style and has dual function as both corporate headquarters and private residence. Throughout the home, the most interesting changes to the domestic planning conventions seem to come from Madame Walker, as seen in the way servant-served spaces are arranged. She went to great lengths to make the spaces servants occupied as safe ones, with things like a large walkout yard next to the service area, an elevator, and recreational exercise equipment available to the staff. Madame Walker used her personal experience as a field worker and house servant to create a space that would be best for the house staff. Much new technology is made accessible to the servants, specifically in the laundry facilities, where Madame Walker herself had spent the most time in her service days. The collaboration between Madame Walker and Tandy was one that was incredibly new and important at the time: both were African-American trailblazers. The first in her family born free after the emancipation of slaves, Madame Walker created an image of self-made Black success in America that is still inspirational and moving today. Tandy himself was born into slavery, went on to get a college education, and became the first African American architect registered in New York State. The home itself is built in an

italianate style, taking advantage of the motifs that had long stood for white success. While some African Americans criticized her for what they viewed as an ostentatious display of wealth, Madame Walker viewed the villa's level of consumption as a visual signifier of her wealth. She had Tandy design the building to fit on the front of the property—closest to the road and the most visible by passerby: the goal of the home was to present the accumulation of wealth and prestige as an achievable goal for African American individuals.

The second case study of women patrons being the stimulant for architectural innovation is the Constance Perkins house, designed by Richard Neutra in Pasadena, California. A professor of art history at Occidental College, Perkins challenged Neutra to come up with a design for a house that was small and affordable in accommodating her lifestyle in a lecture he gave in the 50s. Today, the Constance Perkins house is one of the strongest examples of modern architecture in America. As a single woman with no children, she worked with Neutra to deconstruct the idea of the nuclear family home to something that would better fit her needs. She wanted her bedroom to be unseparated from the rest of the house, so she could work and live the minute she woke up, but the bank refused to finance a house without a traditional bedroom. The solution to this was to create a guest room that Perkins stubbornly kept empty throughout her life in the home. The concept of the home as a space for domestic and family labor was completely reimaged by the pair, with work and creativity as the central themes of the home. She requested large, blank walls to best display a revolving collection of the artwork of students, friends, and peers. Instead of the house's central point being a grand entrance hall or parlor, the heart of the home resides in her studio, which she also slept in, as seen in Figure 2. The house was constructed out of inexpensive materials such as wood, plaster and glass, and was customized to Perkins' smaller stature through lower shelves and countertops; Neutra also designed and scaled down furniture for the home. The financing of the project came from ten thousand dollars from the



**Figure 2: Plan for Constance Perkins' home as designed by Richard Neutra.**

advantages she had as a middle-class, educated white woman, but to illustrate how limited the abilities of the single woman were in the 1950s. The next decade's second wave feminism movement is one that came out of these restrictions, and came from people like Perkins being resolute in their right to exist and be whole without a husband or children. The Constance Perkins house exemplified the power of the single woman and the agency she held in her own life. Its design restrictions only led to Neutra's findings of more creative solutions in material, form, and philosophy. The home emphasized that the aesthetics and values of mid-century modern design, such as clean lines, the blending of indoor and outdoor spaces, and muted and warm tones were not ones meant purely for the powerful and wealthy.

Both Madame Walker and Perkins were able to create a more publicly accessible manifestation of their image through being patrons of their own home. They were able to redefine a domestic space: Villa Lewaro became a gathering space for the revolutionaries born from the Harlem Renaissance, and the Perkins House became a space for creative and artistic growth and learning. They were both incredibly emblematic of their time and the respective struggles each woman endured. To this, Friedman wrote that "usually the first indication of a struggle occurs in defining the contested boundaries between established roles and spheres of activity: home and work; family life and responsibility for children; heterosexual privilege; and divisions of social and economic class"

bank and a loan of three thousand dollars from the wife of an art history chairman at Occidental. Being a woman alone in 1950s society did not allow her privileges that married women could take advantage of. This is not to ignore the



(Friedman 86). As a domestic advisor in the late 1800s, Catherine Beecher Stowe was also creating a home at a turning point in US history. She devised plans for single mother homes: the civil war had killed many fathers and husbands, and had left behind women and children who could no longer fit into the homes they had once occupied. None of Beecher's home plans were ever realized. They served to illustrate her philosophies more than being real plans, but one cannot help but wonder what would've come of their creation. In the case studies presented previously, women's complete control over a living space that extends past the kitchen completely redefines premade and understood concepts of what the home should look like and stand for. Beecher represents the ideas women have had to better their home, and improve the realms of their life that they had control over. Madame CJ Walker overcame struggles and bigotry to become a symbol of what Black women could achieve, and her home has lasted until today as a physical symbol of her power, wealth and legacy. Constance Perkins used the language of modernity to redefine the home as a space that better suited her, physically and psychologically. A woman's place is not in the kitchen, or even the home: a woman's place is in her world and the place she carves out for herself. In having control of the space she inhabits, she is able to leave a permanent mark that outlives her residency and redefine eras of architecture and design.

## **Works Cited**

- Dudley, Tara. "On Madam C.J. Walker's Architecture." *Black Perspectives*, May 2019, [Accessed May 8th, 2023](https://www.aaiahs.org/villa-lewaro-on-madam-c-j-walkers-architecture/) https://www.aaiahs.org/villa-lewaro-on-madam-c-j-walkers-architecture/.
- Ghislaine, Hermanuz. "Outgrowing the Corner of the Kitchen Table." *Design and Feminism: Re-Envisioning Spaces, Places, and Everyday Things*, 1999, [Accessed May 6th, 2023](https://archive.org/details/designfeminismre0000unse/page/n10/mode/1up) https://archive.org/details/designfeminismre0000unse/page/n10/mode/1up.
- Levitt, Sarah. "From Catherine Beecher to Martha Stewart: A Cultural History of Domestic Advice." *The MIT Press*, 2004, [Accessed May 6th, 2023](https://www.jstor.org/stable/pdf/3656842.pdf?refreqid=fastly-default%3A1a575a816135179c1f718ea8fa19513c&ab_segments=0%2Fbasic_phrase_search%2Fcontrol&origin=&initiator=search-results&acceptTC=1) https://www.jstor.org/stable/pdf/3656842.pdf?refreqid=fastly-default%3A1a575a816135179c1f718ea8fa19513c&ab\_segments=0%2Fbasic\_phrase\_search%2Fcontrol&origin=&initiator=search-results&acceptTC=1.
- "Obituary: Constance Perkins; Art Scholar, Professor." *Los Angeles Times*, 12 Mar. 1991, [Accessed May 9th, 2023](https://www.proquest.com/historical-newspapers/constance-perkins-art-scholar-professor/docview/1638593714/se-2?accountid=14505) https://www.proquest.com/historical-newspapers/constance-perkins-art-scholar-professor/docview/1638593714/se-2?accountid=14505.

Schertz Keller, Loretta. "Perkins House Designed to Showcase a Life Architecture." *Los Angeles Times*, 25 Apr. 1990, [Accessed May 9th, 2023](https://www.proquest.com/docview/281105254/abstract/B4EB2251A16E4D1DPQ/1?accountid=14505) <https://www.proquest.com/docview/281105254/abstract/B4EB2251A16E4D1DPQ/1?accountid=14505>.

Strazdes, Diana. "Catharine Beecher and the American Woman's Home." *The New England Quarterly*, vol. XXXII, Sept. 2009. Pages 452-489.

Surmann, Antonia. "The Evolution of Kitchen Design: A Yearning for a Modern Stone Age Cave." *Culinary Turn: Aesthetic Practice of Cookery*, 2017, pp. 47–56.

### **Images Cited**

Figure 1: Beecher's plan for ground floor of a model cottage.

Catherine E. Beecher and Harriet Stowe, *The American Woman's Home* (New York: J.B. Ford & Co, 1869) Page 26

Figure 2: Plan for Constance Perkins' home as designed by Richard

Neutra. A2D Architecture, Blogspot. Accessed June 6th, 2023. <http://a2d-architecture.blogspot.com/2012/05/feature-constance-perkins-house.html>

## LOCAL AND CULTURAL IMPORTANCE OF THE RED ABALONE, A SLOW-TO- RECOVER WANING MUSK

EDEN WINNIFORD



---

*WRITER'S COMMENT: My father and grandfather used to dive for abalone every year, but their annual trips dwindled as red abalone became scarce and stopped altogether once the recreational abalone-fishery closed in 2018. The knowledge and skills required for harvesting abalone is folklore, often passed down from older generations to the ones that follow. The fishery is set to reopen in 2026 — by then, nearly a decade will have passed since anyone has legally harvested abalone. When Dr. Bender tasked her students with writing about an environmental topic of their choice in UWP 102G, I knew I wanted to write about the history and population decline of abalone in Northern California. The fishery exemplifies so much of what is at stake in the broader conversation about the management of California's scarce resources: native subsistence rights, the economies of small towns in rural areas, a dedicated recreational harvesting community, and a history of commercial overharvesting and of racist exclusionary policies.*

*Instructor's Comment: One of the aims of the feature article assignment in my Environmental Writing course (UWP 102G) is to generate audience interest in topics they may have overlooked in the past. In response to this challenge, Eden Winniford presents the red abalone, a physiologically-humble creature that has, as readers will discover, played a starring role in the lives of Pacific Coast communities for centuries. In this multidimensional narrative of red abalone fishing and its impacts on human and marine life, Eden drew upon a wide variety of sources and brought them together seamlessly to create*

*a piece that is equal parts social history, environmental history, and contemporary reporting. While readers will learn much about the red abalone here, this article is also an important reminder of the cascade of effects that may result from environmental interventions more generally.*

*-Melissa Bender, University Writing Program*

Upon first introduction, abalone don't sound or look very appealing. Commonly referred to as sea snails, most of an abalone's body is just one large 'foot,' a powerful suctioning muscle and decent locomotor allowing them to slowly crawl along the ocean floor. Abalone are herbivores and often find food by waiting for the current to bring a piece of loose kelp close by, which they trap with their foot and chew with their radula, a circle of teeth ("Abalone", n.d., Monterey Bay Aquarium). Their outer algae-covered shells can be difficult to distinguish from the rocks they cling to. But their meat, prized for its rich, buttery flavor, and pearly inner shells prove that external appearances aren't everything.



*Figure 1, Red abalone crawling along the seafloor  
Photo from "Red Abalone" by Aquarium of the Pacific, n.d.*

Indigenous peoples were the first to gather abalone by picking them from intertidal zones during low tide and, in some cases, by diving (Bruchac & Ku, 2017). Abalone were a particularly valuable food source because they are nutritious, calorically dense, and could be harvested year-round. Dried abalone meat and fragments of their iridescent shells were used as a bartering currency and were traded with inland tribes. Their shells were also fashioned into jewelry and ceremonial pieces, a practice that continues today and carries significant cultural value. Abalone shells are important in ceremonial regalia for many reasons, including their iridescent shine, the music they make during dance, and the direct connection they provide with Native peoples to Spirit Beings, or “primordial origins” (Bruchac & Ku, 2017; Fields, 87, 2008).



*Figure 2, Photo of regalia adorned with abalone shells  
Photo from “Abalone” by Mary J. Risling, The  
NativeWomen’s Collective, n.d.*

Many northwestern tribes have different and varying stories about Abalone Woman, a Spirit Being who in some tellings became the origin of abalone. In a Hupa telling, Abalone Woman left her family to marry a man who became jealous and abusive (Fields,

2008). She tried to return to her family by walking along the shore, but when she realized her husband would be able to track her footprints in the sand, she began walking on the rocks instead (Fields, 2008).

The sharp rocks cut her feet, making her cry (Fields, 2008). The tears she cried formed abalone shells, which became iridescent to reflect her spirit, and the blood from her feet turned the shells red (Fields, 2008). Callie Lara, a Hupa/Karuk writer, described in the book *Abalone Tales* how this telling demonstrates the societal importance of women and is commonly used to show younger generations that domestic violence is not and was never tolerated in their culture (Fields, 2008).

Abalone have held cultural significance in China for thousands of years, where they were eaten by royalty and are still considered a delicacy today (de Greef, 2018). In the 1800s, Chinese immigrants transformed abalone gathering into an industry in California by exporting dried abalone meat to China (Fields, 2003). Chinese fishermen picked abalone from intertidal zones, but the Chinese Exclusion Act — which led to widespread violence against Chinese communities — and a 1900 ban on gathering abalone from shallow waters drove Chinese out of the industry they had started (Gillespie, 2020; Braje, 2018).

Japanese men continued the commercialization of abalone by freediving for them in Northern California, a practice dating back thousands of years to Japanese women abalone divers (Gillespie, 2020). Over time, Japanese divers began using hard hats, a type of dive suit that connects to an air hose and allows the wearer to spend more time underwater (Gillespie, 2020).

However, the internment of Japanese immigrants and Japanese Americans during World War II locked them out of the abalone industry (Gillespie, 2020).



*Figure 3, A Japanese freediver wearing a hard hat suit and holding a helmet*



*From Palos Verdes Library District, 1905*

Prior to the commercialization of abalone during World War II to increase food production, there were robust populations of California's seven types of abalone: the pinto abalone, lined with unique and delicate bands, the sparkling green abalone, the delectable white abalone, the hardy black abalone, the small flat abalone, the corrugated pink abalone, and lastly, the large red abalone ("Abalone, 2001; "Abalone Species Diversity", n.d.). Between the 1950s and 70s, commercial fishermen brought millions of pink,



green, white, and black abalone ashore, moving from one to the next as the populations of each type crashed (“Abalone,” 2001). In 1997, all commercial fishing for abalone was banned (Callahan, 2018).

Sustainably commercializing abalone is difficult due to the species’ snail-speed growth and density-dependent reproductive strategy. It takes five to six years for red abalone to mature to reproductive age, at which point they begin broadcast spawning, or releasing sperm and egg cells into the surrounding water (“Invertebrates of Interest: Abalone; Abalone: Reproduction and Growth”, n.d.). Larger abalone — which are also more commercially desirable — produce more sperm and eggs, making them more reproductively successful (“Abalone”, n.d., *CDFW*). A denser population will be more likely to reproduce successfully since there will be a greater chance of sperm and egg cells meeting. Broadcast spawning is also a safer bet in a tide pool, which has a limited volume, than in the open ocean, where the likelihood of sperm and egg cells meeting can be smaller.

Although commercial freediving for abalone was introduced to the U.S. by Japanese divers in the early 1900s, it didn’t take off as a recreational sport until the 1950s — a few years after abalone had become a more common food during World War II (“Abalone: History and Future”, n.d.). By the late 90s, just four decades after the sport had ballooned in popularity, all recreational abalone diving south of the San Francisco Bay was suspended under emergency measures and was permanently closed in 2000 (“Historical Summary of Laws and Regulations Governing the Abalone Fishery in California”, n.d.). After 2000, Sonoma and Mendocino County became two of the last California counties where people could harvest abalone, either by diving or picking them from intertidal zones, and only harvesting red abalone was permitted.

Freediving for abalone gave divers long-term friendships with their “dive buddies,” sometimes lasting decades. This camaraderie, the challenge of finding the largest abalone, and getting to eat

abalone meat for dinner brought 35,000 fishers to the North Coast every year (Reid et al., 2016). Many of these fishers visited Sonoma and Mendocino counties, which together accounted for 95% of the annual catch. Abalone gathering and diving became a central part of coastal Mendocino County identity, with recreational harvesters bringing in an estimated \$15 million annually through direct spending like food and lodging (Reid et al., 2016). These benefits enjoyed by abalone harvesters and coastal towns came to a halt when CDFW suspended recreational diving for abalone in 2018 after climate change, decades of overfishing, and bad luck collided to send the northern red abalone population plummeting. It was a disaster a century in the making, beginning with the overfishing of sea otters in the 1800s. Sea otters are a keystone species, or a species whose presence has a significant regulating effect on many other species (“What makes the sea otter a keystone species?”, n.d.).

Sea otters are happy to feed on a variety of hard-shelled invertebrate herbivores, including the abalone, but their preferred prey is the purple sea urchin when abundant (“What makes the sea otter a keystone species?”, n.d.). This regulation of purple sea urchin populations is vital because purple urchins are notorious for devouring entire kelp forests and creating urchin barrens (Cousteau, 1973). While a kelp forest offers food and habitat, urchin barrens are devoid of primary production as urchins gobble up any kelp before it can establish itself, causing other herbivores like the abalone to starve.



*Figure 4, An urchin barren on the California coast  
From “New research to address kelp forest crisis in  
California,” photo by Pike Spector, 2020.*

Sea stars are also effective sea urchin predators and kept their populations in control along the Northern California coastline after sea otters were hunted to near extinction (“What makes the sea otter a keystone species?”, n.d.). A sea star wasting disease, however, struck in 2013 and rapidly decimated sea star populations (Rogers-Bennet & Catton, 2019). Without any significant predators, purple sea urchins ballooned in number and devoured large swaths of kelp forest, transforming these areas into urchin barrens.

A prolonged marine heatwave starting in 2014 that was driven by climate change and El Niño further stressed bull kelp (Sommers, 2021; Rogers-Bennet & Catton, 2019). In 2014 alone, the kelp canopy plummeted by 90% in Marin, Sonoma, and Mendocino counties (Rogers-Bennet & Catton, 2019). The scarcity of bull kelp caused abalone to wither and die from starvation, the effects of which were compounded by the warmer waters as both heat stress and starvation decrease sperm counts in male abalone (Rogers-Bennet & Catton, 2019).



*Figure 5, Usually found on rocks and in crevices, an abalone clings to a bull kelp stalk, looking for leaves  
From “‘Perfect Storm’ Decimates Northern California Kelp Forests,” photo by K. Joe, 2016.*

A starving abalone also has a less powerful foot, and strong storms became mass mortality events by prying abalone off rocks and washing them ashore. By 2017, 80% of the red abalone population had died (Rogers-Bennet & Catton, 2019). Despite the early warning signs that had appeared years earlier — including the sea star wasting disease in 2013 and kelp die-off in 2014 — CDFW did not announce the closure of the recreational fishery until after the population had plummeted in 2017, where it suspended the fishery from 2018 to 2021.

Because abalone are herbivores and rely on bull kelp for survival, abalone populations cannot recover until bull kelp recovers. And bull kelp can't get a foothold and regrow in urchin barrens, where any trace of primary production is rapidly consumed. Nonprofits and research organizations attempted to reduce purple urchin

populations by mobilizing volunteer divers and hiring commercial red urchin divers to bag and destroy purple sea urchins (Sommer, 2021).

Some of these efforts have yielded promising results: In Mendocino County's Noyo Bay, where purple urchins were removed by divers, bull kelp density had significantly increased in 2022 (Esgro, 2022).

Although human removal of purple urchins can lead to increases in kelp density, repopulating sea otters in Northern California would provide a long-term check on purple urchin populations (Cousteau, 1973). This would not be without risks, however, since sea otters are voracious eaters and also prey on abalone. CDFW could mitigate this risk by monitoring sea otter and abalone populations and requesting to work with northwestern tribes to strategically hunt sea otters if their populations become large enough to have negative effects. Northwestern tribes have a long history of managing sea otter populations to maximize bull kelp levels and maintain a sustainable supply of abalone and other shellfish, and their partnership would give CDFW invaluable insight into effective management practices (Fields, 2008).

Despite recent kelp regrowth, the abalone is a slow-growing organism, and it will take more time for red abalone populations to recover. Mass die-off events are especially devastating for a species like abalone, which take years to reach maturity and rely on dense populations to reproduce successfully. Commercial fishing has been banned statewide for decades, but abalone populations that were overfished in the 20th century still haven't recovered. Today, every type of California's abalone is categorized by the International Union for Conservation of Nature as critically endangered, except the pinto abalone, which is endangered and was never commercially harvested (Kerlin, 2022).

Although the moratorium on harvesting abalone in Northern California was expected to expire in 2021, CDFW extended it to 2026, citing low population numbers ("The Recreational Abalone Fishery to Remain Closed Until 2026", n.d.). When recreational

abalone diving does return, recent CDFW surveys and other actions suggest that permits might be distributed via lottery system (“Recreational Red Abalone Fishing Survey Results”, 2015).

A much broader issue in California’s natural resource management is the routine denial of subsistence hunting and fishing rights to Native American tribes, blocking access to culturally important resources (Krol, 2018). In other states, Native American tribes have grounds for subsistence access due to sovereign territory rights, but treaties left unratified by the U.S. Congress in the 1800s make it exceedingly difficult for California tribes to pursue that option (Krol, 2018).

If a lottery system is eventually implemented, CDFW can provide tribes with subsistence access to abalone by guaranteeing a certain percentage of permits for northwestern tribes. CDFW should consult with the tribes to determine this number. Abalone are integral to many northwestern tribes’ culture, ceremonies, and diets, and this long history should be respected and reflected in the distribution of fishing permits. However, this should not be used as a permanent solution; instead, it should be a temporary stopgap to provide tribes with subsistence access until the state and federal governments officially recognize the subsistence rights of all California tribes.

The history of California’s commercial and recreational abalone fisheries have been marked by both social and ecological injustices, as the California government discriminated against and excluded Native and Asian harvesters while allowing the commercial and recreational industry to overfish abalone populations to the brink of collapse. A recreational fishery centered around tribal rights, inclusion, and sustainability will create a fishery more people can enjoy for a long time, rather than one that centers on the needs of few and booms and busts every few decades. The abalone is more than a sea snail — it’s beloved to people belonging to countless communities in California. We just have to make sure it isn’t loved to death.

## **Works Cited**

- Abalone. (n.d.) *California Department of Fish and Wildlife*, <https://www.dfg.ca.gov/marine/pdfs/response/abalone.pdf>
- Abalone. (n.d.) *Monterey Bay Aquarium*, <https://www.montereybayaquarium.org/animals/animals-a-to-z/abalone>.
- Abalone History and Future. (n.d.) *Marine Science*, <https://www.marinebio.net/marinescience/06future/abhist.htm>.
- Abalone Reproduction and Growth. (n.d.) *Marine Science*, <https://www.marinebio.net/marinescience/06future/abrepro.htm>.
- Abalone Species Diversity. (n.d.) *Marine Science*, <https://www.marinebio.net/marinescience/06future/abspsdiv.htm>.
- Bruchac, M. & Ku, K. C. (2017) Song of the Abalone: As Heard from Different Ears. *Penn Museum*, <https://www.penn.museum/blog/museum/song-of-the-abalone-as-heard-from-different-ears/>.

Fields, H. (2003) Battered to Extinction (Also Steamed, Stir Fried, and Eaten Raw). *University of California, Santa Cruz*, <https://sciencenotes.ucsc.edu/0301/abalone/index.html>. Fields, L. W. (2008) Abalone Tales: Collaborative Explorations of Sovereignty and Identity in Native California. *Duke University Press*, <https://ebookcentral.proquest.com/lib/ucdavis/detail.action?docID=1170579>.

Historical Summary of Laws and Regulations Governing the Abalone Fishery in California. (n.d.) *Ocean Trust*, [https://www.oceansciencetrust.org/wp-content/uploads/2018/08/Historical-Summary-of-recreational-abalone-fishery-laws-and-regulations-for-California-5\\_16\\_2018.pdf](https://www.oceansciencetrust.org/wp-content/uploads/2018/08/Historical-Summary-of-recreational-abalone-fishery-laws-and-regulations-for-California-5_16_2018.pdf).

Invertebrates of Interest: Abalone. (n.d.) *California Department of Fish and Wildlife*, <https://wildlife.ca.gov/Conservation/Marine/Invertebrates/Abalone>.

Kerlin, K. (2022) All West Coast Abalones at Risk of Extinction on the IUCN Red List. *University of California, Davis*, <https://www.ucdavis.edu/climate/news/all-west-coast-abalone-added-endangered-iucns-red-list>.

Krol, D. U. (2018) A shrinking supply of abalone shells affects coastal tribes. *High Country News*, <https://www.hcn.org/issues/50.4/tribal-affairs-a-shrinking-supply-of-abalone-shells-impacts-coastal-tribes>.



*Local And Cultural Importance Of The Red Abalone*

Miller, K., Blain, C. O., & Shears, N. T. (2022) Sea Urchin Removal as a Tool for Macroalgal Restoration: A Review on Removing “the Spiny Enemies.” *Frontiers*, 9, <https://doi.org/10.3389/fmars.2022.831001>.

“Perfect Storm” Decimates Northern California Kelp Forests. Photo by K. Joe. (2016) *California Department of Fish and Wildlife*, <https://cdfmarine.wordpress.com/2016/03/30/perfect-storm-decimates-kelp/>

The Recreational Abalone Fishery to Remain Closed Until 2026. (2021) *California Department of Fish and Wildlife*, <https://wildlife.ca.gov/News/the-recreational-red-abalone-fishery-to-remain-closed-until-20261#gsc.tab=0>.

Recreational Red Abalone Fishing Survey Results. (n.d.) *California Department of Fish and Wildlife*, <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=101684&inline>. Red Abalone. (n.d.) *Aquarium of the Pacific*, [https://www.aquariumofpacific.org/onlinelearningcenter/species/red\\_abalone](https://www.aquariumofpacific.org/onlinelearningcenter/species/red_abalone).

Reid, J., Pace, M., Vasquez, F., Eyler, R., Bruner, A., Rogers-Bennett, L., & Kashiwada, J. (2016) The Economic Benefits of the Red Abalone Fishery in Northern California.

*California Department of Fish and Wildlife*, [https://www.conservation-strategy.org/sites/default/files/field-file/EN\\_CSF-CDFW\\_Abalone\\_DP\\_2016.pdf](https://www.conservation-strategy.org/sites/default/files/field-file/EN_CSF-CDFW_Abalone_DP_2016.pdf).

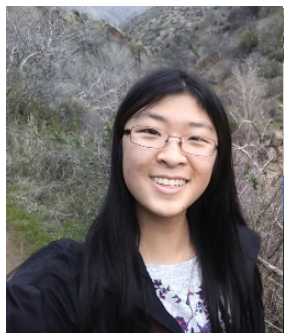
Rogers-Bennett, L., & Catton, C. A. (2019) Marine heat waves and multiple stressors tip bull kelp forest to sea urchin barrens. *Scientific Reports*, 9, <https://doi.org/10.1038/s41598-019-51114-y>.

Spector, P. (2020) New research to address kelp forest crisis in California. *Sea Grant*, <https://seagrant.noaa.gov/News/Article/ArtMID/1660/ArticleID/2796/New-research-to-address-kelp-forest-crisis-in-California>.

What makes the sea otter a keystone species? (n.d.) *U.S. Fish and Wildlife Service*, <https://www.fws.gov/sites/default/files/documents/The%20keystone%20species%20role%20of%20the%20sea%20otter%2007302021.pdf>.

YUROK TRIBE, ET AL. V. UNITED  
STATES BUREAU OF RECLAMATION  
ANALYSIS

MADISON WONG



---

*WRITER'S COMMENT: Through working for a water advocacy organization, I explored the education, media, and advocacy aspects of water policy, a subject area I found increasingly important the more I delved into it. However, it was not until I had the pleasure of taking Professor Tracy Winsor's Environmental Law class that I discovered that law is the facet of water policy that piques my interest most. During the class, I had the opportunity to analyze Yurok Tribe, et al. v. United States Bureau of Reclamation, a water distribution case that has undergone several developments since its initiation in 2019. I thoroughly enjoyed the challenge of compiling information from different sources and concisely presenting the facts, and my hope is that this analysis demonstrates the complex nature of water law while also breaking down the case for a broader audience.*

*INSTRUCTOR'S COMMENT: Yurok Tribe et al. v. U.S. Bureau of Reclamation is a longstanding controversy regarding water use in the Klamath Project. The U.S. Bureau of Reclamation's operation of the Klamath Project demands balancing the needs of multiple species, stakeholders, and sovereigns. I recall warning the class that this case is one of the most challenging and complicated topics a student could choose, involving science and policy as well as state and federal law. Madison was undaunted: she dove in, worked hard, and stayed after lecture for enthusiastic discussions of her topic. Her careful approach to her research and drafting is apparent in the final paper, and her thoughtful evaluation of the likely outcome reflects her deep engagement and interest in the issues presented. Madison is as humble as*

*she is creative and talented, and her instructors are so pleased to know that her scholarship will be recognized in Prized Writing.*

*-Tracy Winsor, Enviromental Science Policy*

## **I. Introduction**

At the core of water management controversies are two facts: there is a limited amount of water available, and there are several parties who need to use water. *Yurok Tribe, et al. v. United States Bureau of Reclamation* (*Yurok v. Reclamation*) is no different. The case centers around the distribution of water stored in a federal reclamation project, and involves irrigators, Tribes, and endangered species across the states of Oregon and California. There are two main legal issues: whether the Oregon Water Resources Department (OWRD) may require the United States Bureau of Reclamation (Reclamation) to withhold Klamath River water needed to satisfy federal Endangered Species Act (ESA) protections for species downstream, and whether the federal government may restrict flows to satisfy ESA protections for one listed species at the harm of another. The challenge of this case is that each legal question applies to a complex, interconnected river system and, as such, changing flows may resolve one issue while giving rise to another. At stake in this case are water allocations for irrigation and endangered species, as well as a precedent for future water management policy where state and federal law conflict.

## **II. Parties And Issue Description**

*Yurok v. Reclamation* involves plaintiffs with stakes in fisheries, intervenor-defendants with stakes in irrigation, and government defendants who administer water infrastructure and species protection laws.

***Defendants and Cross-claimants***

**United States Bureau of Reclamation (“Reclamation”).** Reclamation is a federal agency which constructs, owns, and operates water projects, including the Klamath Project and Link River Dam in Oregon (Motion for Leave to File Supplemental Complaint [Supplemental Complaint] 28). Reclamation consults with other federal agencies to determine the potential environmental impacts of actions the agency undertakes, approves, and funds (Order on Motions for Summary Judgment, Motions to Strike, and Motion to Stay [Summary Judgment] 5). The federal government is seeking declaratory relief against a state department order (*Id.* at 11-12).

**National Marine Fisheries Service (NMFS).** NMFS is the federal agency that reviews information about federal actions and applies its expert knowledge to issue a biological opinion (BiOp) for marine species. The BiOp assesses “the likelihood that the proposed action will ‘jeopardize the continued existence of a listed species’” or its critical habitat and suggests alternative actions if the proposal may cause such jeopardy (*Id.* at 4).

***Plaintiffs And Cross-claimants***

**Yurok Tribe.** The Yurok Tribe has relied on the Klamath River for sustenance, culture, and economic purposes since time immemorial (*Id.* at 6). Presently, the Yurok Reservation includes forty-five miles of the Klamath River. The Tribe holds federally-reserved water rights to the river, and these rights extend to the security of Yurok fisheries (*Id.*). The Tribe seeks protections for salmon and alleges the defendants violated Tribal Trust and the ESA with their 2019 BiOp (*Id.* at 11) and 2023 Temporary Operating Procedure (TOP) (Supplemental Complaint 34).

**Pacific Coast Federation of Fishermen’s Associations (PCFFA) and Institute for Fisheries Resources (IFR).** PCFFA is “the largest organization of commercial fishing families on the west coast” (*Id.* at 26) and IFR is “a non-profit corporation that constitutes the conservation arm of PCFFA” (*Id.* at 27). PCFFA and IFR have “financial and livelihood interests” in salmon fisheries and are seeking protections for Chinook and Coho salmon (*Id.*).

**Hoopa Valley Tribe.** The Hoopa Valley Tribe is a cross-claimant. The Tribe has federal reserved water rights and a Reservation that “constitutes a nearly 12-mile square at the confluence of the Klamath and Trinity Rivers” (Summary Judgment 7). The Hoopa Valley Tribe also seeks protections for Chinook and Coho salmon.

***Intervenor-Defendants, Crossclaim-Defendants, And Counter-Claimants***

**Oregon Water Resources Department (OWRD).** OWRD seeks to “address Oregon’s water supply needs” and “restore and protect streamflows and watersheds in order to ensure the long-term sustainability of Oregon’s ecosystems, economy, and quality of life” (OWRD 2023). Following a Marion County Circuit Court decision, OWRD ordered Reclamation to “stop the distribution, use or release of stored water from the . . . [Upper Klamath Lake]” (Order Regarding Release of Water Stored Under Determined Claim KA 294 [Order] 10).

**Klamath Water Users Association (KWUA) and Klamath Tribes.** KWUA is a “private corporation that has represented farmers and ranchers working on Klamath Reclamation Project in its current form since 1953” (KWUA 2023). The federally-recognized Klamath Tribes include the Klamath, Modoc, and Yahooskin-Paiute People located on the Klamath Reservation at the head of the Klamath River (Klamath Tribes 2023). Both parties rely on water in the Upper Klamath Basin and thus have an interest in the decision to hold or release stored water (Order 5).

**Klamath Irrigation District (KID).** KID is an intervenor-defendant. KID’s mission is “to acquire, maintain, assure, and deliver an adequate water supply for beneficial use on qualified land with the Klamath Project” (KID 2023). KID brought the lawsuit in the Marion County Circuit Court and petitioned Reclamation to stop releasing water from the Link River Dam (Order 3).

***Issue***

In July 2019, the plaintiffs claimed the defendants violated federal ESA and Tribal Trust obligations with NMFS’ 2019 BiOp and Reclamation’s Tribal consultation process for Chinook and Coho salmon.

The ESA is federal law which protects threatened and endangered species (16 U.S.C. § 1531), including Southern Oregon/Northern California Coast Coho salmon and Southern Resident killer whales, which primarily prey on Chinook salmon (State of California’s Amicus Curiae Brief in Support of No Party [Amicus] 10). Tribal Trust is a federal obligation to protect Tribal resources (Pevar 3), including Coho and Chinook Salmon (Supplemental Complaint 25). The plaintiffs argued the BiOp provided inadequate Klamath River spring flows for protecting habitat and mitigating disease (*Id.* at 38). After agreeing upon an Interim Operating Plan with increased spring flows for salmon, however, the parties paused legal proceedings until September 30, 2022 (Summary Judgment 11).

In April 2021, OWRD ordered Reclamation not to release Klamath River water from the Upper Klamath Lake (UKL) under Section 8 of the 1902 Reclamation Act. Section 8 expressly states that: “[n]othing in this Act shall be construed as affecting or intended to affect or to in any way interfere with the laws of any State or Territory relating to the control, appropriation, use, or distribution of water used in irrigation” (43 U.S.C. § 383). Since Section 8 generally requires Reclamation defer to state water law in project operation and the ORWD Orders would reduce flows needed to protect endangered species in the lower Klamath River, the parties in *Yurok v. Reclamation* resumed litigation (Amicus 8). The Northern District Court of California ruled in response to the parties’ cross motions for summary judgment that ESA protections conflict with and have priority over operation of the OWRD Orders issued under Oregon state water law (Summary Judgment 34). The counter-claimants appealed the district court ruling.

In January 2023, Reclamation released a TOP which permitted the agency to increase UKL water levels to protect the habitat of ESA-listed suckers (Supplemental Complaint 36). Reclamation declared the TOP would not significantly impact endangered species. However, the plaintiffs challenged this finding because the plan would allow Reclamation to reduce flows up to 30% below the interim requirements, threatening salmon spawning grounds downstream and consequently violating the ESA (*Id.* at 10).

### III. Relevant Laws

The key federal obligations involved in *Yurok v. Reclamation* are the Endangered Species Act and Tribal Trust. The Reclamation Act and Supremacy Clause are also relevant to evaluating the OWRD Orders.

**Endangered Species Act.** The ESA is federal law designed to protect “endangered species and threatened species” and the ecosystems on which they depend (16 U.S.C. § 1531(b)). ESA Section 7 applies this protection to “any action authorized, funded, or carried out by” a federal agency (*Id.* § 1536). As such, Reclamation must administer the Klamath Project without jeopardizing ESA-listed shortnose suckers, Lost River suckers, Coho salmon, or Southern Resident killer whales or their critical habitats (Summary Judgment 5-6). Otherwise, if their action may have an adverse impact, Reclamation must provide information to and consult with NMFS. NMFS will then issue a BiOp, as it did with the 2019 BiOp the plaintiffs challenged (*Id.* at 4). Notably, Reclamation may disregard the BiOp at the risk of violating ESA Section 9, which prohibits the take of any listed species (16 U.S.C. § 1538(a)(1)(B)). Within the ESA, “‘take’ means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (*Id.* § 1532(19)).

*Tennessee Valley Authority (TVA) v. Hill* (1978) was the first Supreme Court case to interpret the ESA. The Court declared that “the Endangered Species Act of 1973 represented the most comprehensive legislation for the preservation of endangered species ever enacted by any nation” (*TVA v. Hill* 1978). The Court found that “the language of ESA ‘reveals a conscious decision by Congress to give endangered species priority over the “primary mission” of federal agencies’” (Amicus 14). For example, the Court noted the ESA’s requirement that federal agencies use “all methods and procedures” to reach a point where ESA protections “are no longer necessary” (16 U.S.C. § 1532(2)).

**Tribal Trust Doctrine.** Tribal Trust is a federal obligation to protect Tribes’ “self-government and economic prosperity” (Pevar 3). As stated in *Baley v. United States* (2019), “the creation of a tribal reservation carries an implied right to unappropriated water ‘to the extent needed to accomplish the purpose of the reservation’” (Opinion 43). Therefore, the Yurok, Hoopa Valley, and Klamath Tribes acquired federal reserved water rights as of the establishment date of their respective Reservations (Summary Judgment 6-7). These rights entitle the Tribes to “prevent



other appropriators from depleting the streams' waters below a protected level in any area." Furthermore, Tribes are entitled to "the government's compliance with the ESA in order to avoid placing the existence of their important tribal resources in jeopardy" (*Id.* at 7). Relevant to *Yurok v. Reclamation*, suckers and lampreys are important resources to Klamath Tribes, and salmon are important resources to the Hoopa Valley and Yurok Tribes (*Id.* at 6).

**Reclamation Act.** Section 8 of the Reclamation Act provides that nothing in the Act shall be construed to interfere with state laws "relating to the control, appropriation, use, or distribution of water used in irrigation . . ." (43 U.S.C. § 383). Relying on the purposeful deference to state water law in Section 8, the OWRD issued orders for Reclamation to stop releasing water from the UKL because KID required this water "for irrigation purposes within the Klamath Project" (Order 8).

**Supremacy Clause.** The Supremacy Clause of the United States Constitution states that the Constitution and "the Laws of the United States which shall be made in Pursuance thereof" are the "supreme Law of the Land" (U.S. Const. art. VI, cl. 2). The 2012 Supreme Court case *Arizona v. United States* interpreted the clause to mean Congress has "the power to preempt state law" (567 U.S. 387, 399). Additionally, the Supreme Court cases *California v. United States* (1978) determined that federal agencies "should follow state law in all respects not directly inconsistent with . . . [directions by Congress]" (438 U.S. 645). By applying this ruling, the Northern District Court's summary judgment declared that the ESA preempts the OWRD Orders because storing water reduces would adversely affect critical salmon habitat on the Klamath River, "increasing the water temperature, and lowering dissolved oxygen levels" as well as increasing "risks to Coho salmon associated with the *C. shasta* parasite" (Summary Judgment 6).

#### IV. Evaluation

Since the case began in 2019, *Yurok v. Reclamation* has shifted focus, with the case most recently focusing on the plaintiffs' initial allegations regarding the 2019 BiOp, the OWRD Orders to stop Reclamation from releasing water from the UKL, and the plaintiffs' supplemental complaint regarding the 2023 TOP.

In evaluating the 2019 BiOp and 2023 TOP, the relevant legal issue

is whether Reclamation may jeopardize an ESA-listed species or adversely affect its critical habitat. The question becomes further complicated if Reclamation's action seeks to satisfy ESA protections for one listed species at the expense of another. The ESA prohibits actions by a federal agency that jeopardize the continued existence of an endangered species or adversely modify its critical habitat. In this case, the 2019 BiOp did not leave enough water in the Klamath River to ensure necessary spring flows for salmon spawning habitat and disease mitigation. Therefore, had the parties not agreed upon increased flows for salmon in the Interim Operating Plan, the court would likely have ruled in favor of the plaintiffs. When Reclamation allowed for reduced flows in the 2023 TOP, on the other hand, the agency did not necessarily violate the ESA. While the plaintiffs argued the TOP would adversely modify salmon spawning habitat, thus violating the ESA, Reclamation made this decision to benefit ESA-listed suckers upstream. As such, the legality of the 2023 TOP depends on whether Reclamation considered all consultation required by the ESA and Tribal Trust. Other relevant considerations are whether there are alternative ways for Reclamation to protect suckers without reducing water for salmon, and whether the harm to salmon is greater than the benefits to suckers.

In evaluating the OWRD Orders, the legal issue is whether the OWRD has the authority to order Reclamation to withhold water needed to satisfy federal obligations. Section 8 of the Reclamation Act allows for the storage and distribution of water for irrigation purposes. Yet, the findings of *California v. United States* established that state law can not conflict with directives written by Congress. In this case, since Congress wrote the ESA, the ESA preempts the OWRD Orders and allows Reclamation to release water from the UKL to facilitate the survival of ESA-listed salmon and killer whales downstream. On appeal, the court will likely re-examine whether the flows were necessary to protect downstream species. Based on the facts presented in the District Court, the appellate court is likely to affirm that releasing water is not a violation of the Reclamation Act due to the government's overriding duty to comply with the ESA.

From a policy perspective, the better result would arguably be a decision in favor of conserving endangered species and their habitat. The Biden-Harris Administration launched the America the Beautiful Initiative in 2021 with "a goal of conserving at least 30 percent of U.S.

lands and waters by 2030” (The White House 2021). California Executive Order N-82-20 established the same goal for the State of California in 2020 (Newsom 2020). California defines a conservation area as: “Land and coastal water areas that are durably protected and managed to sustain functional ecosystems [. . .] and the diversity of life that they support” (California Natural Resources Agency 2023). An appellate court decision favoring irrigation interests over critical habitat would run counter to these goals. Given the significant Tribal advocacy aspect of this case, the outcome of *Yurok v. Reclamation* will also reflect on racial equity and Tribal relationships in the West Coast. Reclamation stated its continued support for “Racial and Economic Equity through commitments to underserved communities and Tribal areas” in their 2024 budget request (Reclamation 2023). While a court decision does not necessarily reflect the interests of Reclamation, any actions Reclamation takes to consult with Tribes and potentially reach a negotiated resolution would support the agency’s policy statement.

## **V. Conclusion**

*Yurok v. Reclamation* revolves around the allocation of water in the Klamath River watershed, which is a complex, interconnected river system. The case affects multiple groups, including government agencies, irrigators, Tribes, and endangered species, and has two main legal issues regarding 1) whether the OWRD can order Reclamation to withhold water needed to satisfy ESA protections and 2) whether the federal government can restrict flows to satisfy ESA protections for one listed species at the harm of another.

In evaluating the OWRD Orders, the Northern District Court of California has found the OWRD does not have the authority to order Reclamation under the Reclamation Act to withhold water needed first and foremost to satisfy federal ESA and Tribal Trust obligations. The appellate court is likely to agree that the ESA preempts Oregon state water law. In evaluating the plaintiffs’ challenges to Reclamation’s Temporary Operating Plan, the appellate court will likely remand the case for further discovery on alternative actions Reclamation may be able to take to protect both upstream and downstream endangered species. Given recent policy statements made by the federal government and California, the better outcome of *Yurok v. Reclamation* from a policy perspective

would be a decision in favor of conserving endangered species and their habitat and prioritizing racial equity. Regardless of outcome, the scope and complexity of *Yurok v. Reclamation* will set an important precedent for water management on the Pacific Coast.

## **VI: References**

About Us, *Klamath Water Users Association* (7 May 2023, 11:00 AM), kwua.org/about-us.

About Us, *Oregon Water Resources Department* (7 May 2023, 11:00 AM), www.oregon.gov/owrd/aboutus/Pages/default.aspx.

*Arizona v. United States*, 567 U.S. 387, 399 (2012).

Biden- Harris Administration Outlines “America the Beautiful” Initiative, *The White House* (6 May 2021), www.whitehouse.gov/ceq/news-updates/2021/05/06/biden-harris-administration-outlines-america-the-beautiful-initiative.

*California v. United States*. 438 U.S. 645 (1978).

Endangered Species Act. 16 U.S.C. § 1531-1544 (1973).

Home, *Klamath Irrigation District* (7 May 2023, 11:00 AM), klamathid.org.

Klamath Tribal History, *Klamath Tribes* (7 May 2023, 11:00 AM), klamathtribes.org/history.

Motion for Leave to File Supplemental Complaint, *Yurok v. Reclamation*, No. 3:19-cv-04405-WHO (N.D. Cal. 8 Mar 2023).

Newsom, Gavin. Executive Order N-82-20, *Office of Governor Gavin Newsom* (7 October 2020), www.gov.ca.gov/wp-content/uploads/2020/10/10.07.2020-EO-N-82-20-.pdf.

Opinion, *Lonny E. Baley, et al. v. United States, et al.*, No. 18-1323 (Fed. Cir. 2019).

Order on Motions for Summary Judgment, Motions to Strike, and Motion to Stay, *Yurok v. Reclamation*, No. 3:19-cv-04405-WHO (N.D. Cal. 6 February 2023).

Order Regarding Release of Water Stored Under Determined Claim KA 294, *Klamath Irrigation District v. Oregon Water Resources Department, et al.*, No. 20-cv-17922 (Marion County Circuit Court. 6 Apr 2021).

Pevar, Stephen L. The Federal-Tribal Trust Relationship: Its Origin, Nature, and Scope, *California Water Library* (May 2017), [cawaterlibrary.net/wp-content/uploads/2017/05/The-Federal-Tribal-Trust-Relationship.pdf](http://cawaterlibrary.net/wp-content/uploads/2017/05/The-Federal-Tribal-Trust-Relationship.pdf).

President's Fiscal Year 2024 Budget Requests \$1.4 Billion for the Bureau of Reclamation, *Bureau of Reclamation* (9 March 2023), [www.usbr.gov/newsroom/news-release/4441](http://www.usbr.gov/newsroom/news-release/4441).

Reclamation Act. 43 U.S.C. § 383 (1902).

State of California's Amicus Curiae Brief in Support of No Party, *Yurok v. Reclamation*, No. 3:19-cv-04405-WHO (N.D. Cal. 7 Dec 2022).

Supremacy Clause. U.S. Const. art. 4, cl. 2.

*Tennessee Valley Authority v. Hill*, 437 U.S. 153 (1978).

30x30 Resources, *California Natural Resources Agency* (14 May 2023, 6:00 PM), [www.californianature.ca.gov/pages/resources](http://www.californianature.ca.gov/pages/resources).

## REINING IN THE WEST'S WILD HORSE POPULATION: WHAT IS THE DEBATE?

HOLLY EBERHARD



---

*WRITER'S COMMENT: When I was ten years old, I wrote to the Secretary of the Interior to inform him of my concerns regarding federal management of the wild horses in Nevada. Brimming with youthful righteousness, I was convinced that the removal of wild equines from public rangeland was a contemptible management strategy because it contradicted my own blinkered perspective. In the years since, I have gained a deeper understanding of the complexities of wildlife conservation; idealism can only get one so far when a multitude of stakeholder viewpoints and questions of technical feasibility come into play. When given the opportunity to write about an environmental topic in UWP 102G (Environmental Writing), I knew I wanted to delve deeper into wild horse management in order to illustrate the nuances that I myself did not understand when I first encountered the issue over a decade ago. Although I took some creative liberties with my writing style, the aim of this article is to inform readers and present the different narratives regarding wild horses and the continuing question of overpopulation.*

*INSTRUCTOR'S COMMENT: In UWP 102G: Writing in the Environmental Sciences, I asked students to write an environmentally focused, research-driven popular science article. Holly chose to explore the contentious realm of wild horse management, delving into the historic roots of the conflict and its current challenges. Her article opens with an anecdote that illuminates the cruel fate of wild horses sent to slaughter by ranchers, capturing the reader's attention and setting the stage for the enduring struggle between those who seek to protect wild*

*horses and those who view them as a threat to their livelihood. In good journalistic form, she presents both sides of the argument, inviting readers to understand the perspectives of ranchers who struggle with wild horse overpopulation on grazing lands and advocates who strive to preserve the horses' freedom and ecological significance. She weaves historical context, current data, and expert opinions, bringing life to this complex issue. Because of Holly's thorough research and careful analysis, the reader learns that finding a solution requires cooperation among stakeholders and creative approaches to sustainable management.*

*-Andrea Ross, University Writing Program*

It was the blood dripping from the livestock trailer that caught Velma Bronn Johnston's attention. The year was 1950. Johnston was wending her way along the base of the Sierra Nevada Mountains on her way to work in Reno, Nevada when she drove up behind the truck. As it jounced along the gravel road in front of her, she was alarmed by the sight of blood seeping from under the trailer door, leaving a trail of crimson in its wake. Certain that something was amiss, Johnston followed the truck as it turned into a livestock slaughter yard, surreptitiously approaching the trailer once the driver had walked away. Peering through a gap in the metal slats on the side, she was confronted with a gruesome scene. A stallion lay disfigured on the trailer floor, trampled to death by its terror-stricken companions. Other horses oozed blood from gunshot wounds in the leg or eye.

Upon interrogating the driver on his return, Johnston learned that they were wild horses who ranchers had rounded up on Nevada's public range and sent to slaughter, many of them horrifically abused in the process. Appalled by the inhumane treatment of an icon of the American West, Johnston began a lifelong campaign to protect wild horses, earning her the moniker "Wild Horse Annie."

Velma Johnston's impassioned advocacy for wild horses was the driving force behind Congress passing the Wild Free-Roaming Horses and Burros Act of 1971 which protected wild equines from "capture, branding, harassment, and death" (Public Law 92-195). Yet over fifty

years later, the management of wild horses and burros on public lands in the Western U.S. remains a contentious issue.

While many Americans romanticize wild horses as a fixture of the original Western Frontier, the ranching industry remains unenamored. Wild equine populations have burgeoned in recent decades, creating a critical overpopulation issue on public lands that directly affects livestock profitability, frustrating ranchers to no end. It has fallen upon the Bureau of Land Management (BLM) – the primary federal agency with jurisdiction over public lands – to rectify this issue and attempt the near impossible: find a management solution that appeases everyone.

After the implementation of the 1971 Act, wild horse and burro populations grew rapidly, their numbers unchecked by predation or slaughter. They currently number around 82,000 in total, with over two thirds found on Nevada's rangeland and the remaining herds dispersed across nine other western states (BLM n.d.). This population size might not seem inordinately large given the vast expanses of BLM land in the west, but due to the multi-use nature of these lands, the BLM has set a target of 30,000 wild equines, less than half of the current population.

The primary source of contention between ranchers and wild horses is the fact that both are in competition for limited grazing access on public rangeland. While the horses can roam freely, ranchers are beholden to strict BLM regulations that limit when, where, and to what extent they can put out their livestock to graze in order to avoid rangeland degradation. Nevada rancher Gracian Uhalde explained that his frustration stems from the fact that wild horses are permitted to be on rangeland at all times, but if he did that with his livestock, he would be committing a crime. Ranchers can indeed incur fines or even be subject to lawsuits if they violate these regulations and keep their livestock on overgrazed land, even if much of the degradation could be attributed to wild equines. Consequently, many ranchers are forced to decrease their herd sizes in order to lessen their impact, resulting in a loss of profit and forcing some out of business altogether.

Antagonized by these losses, some in the ranching industry have pushed for amending the existing Horses and Burros Act in order to legalize slaughter as originally practiced, but this suggestion has been met with vehement pushback from advocacy groups and legislators alike. Ben Masters, a member of the BLM's National Wild Horse and Burro Advisory Board and a pro-slaughter advocate, admitted, "It's political



suicide for a politician to take on the cause of, 'Let's save our perennial grasses by killing symbols of the American West'"(Lokting 2020). Due to wild horses' charismatic nature and the indomitable power they hold over the American imagination, it is unlikely that equine slaughter will be a socially accepted practice once again, much to the chagrin of the more pragmatic members of agrarian society.

Others in the ranching industry are more concerned with the environmental implications of what a rapidly swelling equine population means for the land. Jackie Ingram—a cattle rancher in Challis, Idaho—stated, "We like the [wild] horses, but we also want to protect the land[...] If the horses get too numerous, it affects the sage grouse, the elk, the antelope and us. All of us depend on grass" (Phillips 2020).

The ecological impacts of wild horses have been widely debated. Some research indicates that the overabundance of equines has led to the decline of native plant species, particularly native grasses and plants found in fragile riparian areas. Studies also claim that wild horses and burros outcompete various ungulate species such as elk, pronghorn and deer with regard to grazing and water resources (Davies & Boyd 2019). Since wild horses and livestock frequently occupy the same rangeland, it is difficult for researchers to conclusively determine whether signs of degradation can be attributed solely to equines or to cattle and sheep as well. However, there is substantial evidence that points towards future ecological decline as wild horse and burro populations continue to expand. According to the BLM, their numbers are currently doubling every four years (BLM 2022).

Wild horse and burro advocates, on the other hand, argue that the issue is not the overpopulation of equines but rather overgrazing on the part of the livestock industry (American Wild Horse Campaign n.d.). Advocacy organizations – led by the Humane Society of the United States and American Wild Horse Campaign – have been at a constant impasse when it comes to negotiating management terms with ranchers. While the ranching industry is influential in states where ranching contributes significantly to the local economy, conservation groups have amassed a strong national base and have been effective in lobbying directly to the federal government to prevent the legalization of equine slaughter.

Advocacy coalitions have also been severely critical of the BLM's annual roundups which can remove up to 20,000 wild horses and burros from public rangeland. The animals are shipped to federal holding facilities where they await adoption; there are currently 50,000 wild equines in BLM facilities with very little additional capacity because adoption rates are low, leaving the animals to languish for years (BLM n.d.).

In order to orchestrate a system by which wild horses were quickly adopted, the BLM implemented a federally funded program in 2019 that incentivized the adoption of wild horses by paying the adopter \$1,000 per horse. The idea was to make the adoption of an untrained horse a more attractive option and less of a burden by providing initial funding that could go towards training or caretaking.

The system was initially hailed as a success with thousands of adoptions within the first year. However, this success was entirely deceptive. It came to light in a *New York Times* investigation that many of the horses were sold to slaughterhouses directly after adoption by individuals seeking to make a profit (Phillips 2021). The BLM has since worked to implement a more thorough post-adoption check-in system to prevent such transactions from occurring and ensure the wellbeing of the horses.

Fertility control has also been a management option that has been under development within the BLM for the last decade. There are currently two birth control vaccines utilized by the agency: Porcine Zoonosis Pellucida (PZP) and GonaCon-Equine (BLM 2021). Both can be administered to mares via dart guns in the field, but larger herds often have to be taken into temporary captivity to prevent them from spooking and running away before the females can be darted.

The main obstacle to this management strategy is that these vaccines need a booster every few years in order to continue being effective. This is difficult for the BLM to regularly carry out, primarily due to a lack of sufficient funds and manpower. The federal government continues to fund research investigating whether a fertility control option can be developed that does not require readministration. Volunteers for some advocacy organizations such as American Wild Horse Campaign undertake training and assist with darting efforts on the range.

Although federal-level management strategies have not experienced much success with regard to the wild horse dilemma, several small-scale independent efforts geared towards the adoption of wild horses have met more favorable outcomes.

One is the Devil's Garden Colt Challenge in Alturas, California, a program that selects young equine enthusiasts between the ages of 9-19 to take home wild horses and train them for six months in preparation for public adoption (Shannon & Cowan 2022). At the end of the program, the proud equine-wrangling youths have the opportunity to show off their progress in a competition where they must lead their horse through a series of domestic obstacles. The intent of the challenge is to provide adoptable horses with some basic training while allowing the next generation of equestrians to obtain the practical and character-building skills that derive from training an unbroken horse.

There are also a number of organizations that save wild horses on the brink of (illegal) slaughter and facilitate a more thorough adoption process to ensure they go to good homes. A few include the Wild Horse Sanctuary in Shingletown, CA, Wild Horse Connection in Statecoach, NV, and Skydog Ranch in Prineville, OR.

As with many wildlife management issues, finding a solution to the overpopulation of wild horses has plagued the BLM for years and will likely continue to do so in the absence of an agreed-upon approach by the various stakeholders.

Celeste Carlisle, a biologist with the wild horse advocacy group Return to Freedom, candidly acknowledged, "Our public lands are multiuse and so, regardless of what our personal opinions are or our hopes and dreams for our utopia view of what public lands are, we have to operate within these parameters..." (Masterson 2019). Public commons are not the property of a single entity and thus necessitate the cooperation of the involved parties in order to reach a joint management decision.

If the efficacy of fertility vaccines advances soon, then fertility darts could become a viable solution. The BLM recently authorized two new studies researching fertility control vaccines that could potentially bypass some of the salient shortcomings of the previous vaccines (BLM 2020). If these were to prove longer-lasting in their potency, horse and burro populations could be managed in a sustainable and humane manner, curbing their rapid reproduction rate and gradually returning to the BLM's desired number of around 30,000.

In the meantime, the BLM has 50,000 wild horses and burros on their hands with an influx that far outpaces the rate of adoption. Velma Johnston succeeded fifty years ago in discontinuing wild horse slaughter as a management practice, but her efforts produced unforeseen complications. In order to preserve the integrity of wild horse populations and the lands on which they roam, a solution to their rapidly growing numbers is needed fast.

## References

- American Wild Horse Campaign. (n.d.). Wild horses and the ecosystem. <https://americanwildhorsecampaign.org/wild-horses-and-ecosystem>
- Bureau of Land Management. (2022). Bureau of Land Management reissues solicitation seeking services to expand fertility control efforts for wild horses and burros. <https://www.blm.gov/press-release/bureau-land-management-reissues-solicitation-seeking-services-expand-fertility>
- Bureau of Land Management. (2021). Top 5 things to know about wild horse and burro fertility control. <https://www.blm.gov/blog/2021-09-29/top-5-things-know-about-wild-horse-and-burro-fertility-control>
- Bureau of Land Management. (2020). BLM begins a new fertility control trial as overpopulation of wild horses and burros on public lands reaches new heights. <https://www.blm.gov/press-release/blm-begins-new-fertility-control-trial-overpopulation-wild-horses-and-burros-public>
- Davis, K & Boyd, C. (2019). Ecological effects of free-roaming horses in North American rangelands. *BioScience*, 69, 7, p.558-565. <https://doi.org/10.1093/biosci/biz060>
- Lotking, B. (2020). In the West, wild horses are a problem- and ranchers and animal rights activists are locked in conflict over their fate. *The Washington Post*. <https://www.washingtonpost.com/magazine/2020/11/18/wild-horses-ranchers-animal-rights-activists/>
- Masterson, K. (2019). High wild horse numbers have ranchers concerned. KUNR Public Radio. <https://www.kunr.org/energy-and-environment/2019-07-24/high-wild-horse-numbers-have-ranchers-concerned>

- Philipps, D. (2020). A mustang crisis looms in the West. The New York Times. <https://www.nytimes.com/2020/03/22/us/mustang-crisis-west.html>
- Philipps, D. (2021). Wild horses adopted under a federal program are going to slaughter. The New York Times. <https://www.nytimes.com/2021/05/15/us/wild-horses-adoptions-slaughter.html>
- Popescu, A. (2021). Corraling wild horses in the US. New Scientist, 248, 12. <https://www.proquest.com/magazines/corraling-wild-horses-us/docview/2489011836/se-2>
- Public Law 92–195. 1971. Wild Free Roaming Horses and Burros Act. Authenticated U.S. Government Information. Washington, DC: U.S. Government Printing Office. <https://www.gpo.gov/fdsys/pkg/STATUTE-85/pdf/STATUTE-85-Pg649.pdf>
- Shannon, M., & Cowan, J. (2022). Some kids play sports. These kids train wild horses. The New York Times. <https://www.nytimes.com/2022/09/17/us/california-horses-kids.html>

## MIRACLE POWDER OR ELIXIR OF DEATH?

JAKE CAMPO



---

*WRITER'S COMMENT: The story behind DDT always struck me as particularly fascinating — after all, not every scientific development gets such a complete story arc so full of drama and politics. However, though I had studied the basic story and resulting policy in high-school, I had never explored the raw science behind DDT. My opportunity came this year when Dr. Herring asked our class to write “an explanation of a scientific development for the general public.” He suggested the strategy of choosing a topic that overlapped with our other classes and I knew I had to choose DDT: I was in both a biology and chemistry class at the time. And I must say, it was exceptionally fun to write, a testament to Dr. Herring and his methods of teaching. I hope my retelling of this cautionary tale demonstrates why so many—including myself—are captivated by the interdisciplinary field of environmental science: not only does it deal in the vast sciences of chemistry and biology but it simultaneously explores business, politics, and human nature all in one swing.*

*INSTRUCTOR'S COMMENT: There is a kind of scientific writing for the general public that I think of as Extreme Explaining; such writing devotes large amounts of space to the most abstract and difficult-to-understand concepts, but then links them to much greater issues. Richard Rhodes' classic *The Making of the Atomic Bomb* is an example, a book that includes hundreds of pages of exacting explanation of what happens inside an atom—but which ultimately connects the physics with the most earth-shattering events. I have attempted to arrange things so that our more advanced undergraduates can try*

*their hand at something like that, and here is one remarkable result. Jake, our winner, is responding to the final assignment in my History of Scientific Writing class, one that asks the students to explain a historical development in a given science, but leaves the rest to them. In describing the history of the pesticide DDT, Jake shows himself a master of focus, repeatedly narrowing to consider the basic chemistry of DDT, then widening to link the chemistry with its broader effects. What we have here is writing skill that is—well, Extreme.*

*Scott Herring, University Writing Program*

Othmar Zeidler, brow furrowed in concentration, stood before a cluttered lab bench at the University of Strasbourg, studying the progress of his reaction. It was 1874 and Zeidler was a 24 year-old doctoral student working on his dissertation. He frowned; this reaction was proceeding much slower than the last. But as white, felt-like needles began to crystallize, he nodded to himself and turned to scribble in his notebook. He watched for another second before moving on to boil the solution with potassium. Zeidler had just synthesized one of the most infamous pesticides in all of human history, but knew nothing of it.

Sixty-five years later, Paul Herman Müller lugged back to the experiment room of Geigy pharmaceutical in Basel, Switzerland. It had been a long night of trials and, in fact, a long 4 years of work without much to show for it. Motivated by the unprecedented typhus epidemic raging in Russia and a large food shortage in his home country of Switzerland—both caused by uncontrolled insect infestation—Müller had begun looking for the perfect pesticide. At the time, the only options were either too expensive or too weak, excluding arsenic (which, of course, is highly toxic to humans). His search had begun in 1935. It was now September of 1939. He was determined and far from discouraged, but, tonight, the 36-year old was tired. Müller didn't even bother to glance at the fly cage as he passed through the door frame. He crossed the quiet room to retrieve his notes before stopping mid-stride. The room was... quiet. His head snapped to the cage and his eyes lit up. The fly that had been buzzing noisily just minutes earlier lay motionless at the bottom of the cage.



The cage was laced with the same compound that Zeidler first synthesized, published, but failed to investigate in 1874: DDT, short for dichlorodiphenyltrichloroethane. It was the perfect blend of power and affordability, and Geigy moved quickly, securing a Swiss patent in 1940 as World War II erupted in Europe. DDT was an enormous success for British and American troops, saving the lives of thousands by controlling the spread of insect borne diseases such as malaria, typhoid fever, and the aforementioned typhus. In 1945, just one month after the war ended, DDT was released for commercial sale and saw large-scale agricultural use in the years following. It quickly gained the status of miracle powder, especially in the United States which, aided by DDT, had become one of the world's largest food producers. The government was absolutely

delighted and propaganda ensued; DDT was both embraced and celebrated in the post-war world.

So what about DDT makes it such an incredible insecticide? Why is it so toxic to insects but (seemingly) not acutely harmful to humans? To get a sense of the compound's basic function, we must examine two characteristics: its insolubility and

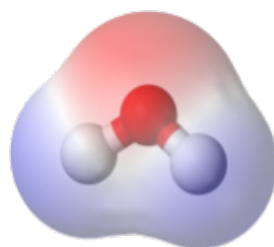
disruption of nerve cells. Molecules that are soluble in water are pulled apart by the water molecules around it, while insoluble molecules are not. Why? Well, soluble molecules (and water itself) have polarity, a characteristic that arises in bonded atoms when electrons are unevenly shared. A sufficient difference in how tightly each atom species holds their electrons leads to partial charges in areas of the molecule. The side holding the electrons more tightly will be slightly negative (since electrons have a negative charge) while the side holding them more loosely will be slightly positive. Thus, if a polar molecule with partial charges interacts with water—also polar with partial charges—the opposite charges will attract and the atoms making up the molecule will be pulled apart by the water surrounding it: the molecule is water soluble.

Pesticides like diazinon—also developed at Geigy—dissolve in water and thus pose threats to drinking water sources. But DDT is insoluble in water. Great! So does DDT avoid being a water contaminant? Comparatively, yes. But, unfortunately, this insolubility has its own



*DDT advertisement, 1947. Courtesy of Times magazine.*

downsides. Because DDT isn't pulled apart easily it is very persistent in the environment. This was great for Müller because it offered long lasting protection on crops without the need for frequent reapplication. But it is so persistent that it continues to move through the food chains and buildup in fatty tissue; just as polar molecules dissolve in polar substances, nonpolar molecules such as DDT dissolve in nonpolar substances such as the fats that are especially present in mammal bodies. This bioaccumulation means that an individual organism gains more and more DDT as it's exposed to it over time. When this organism is eaten by a predator, the predator absorbs the accumulated DDT. And because predators eat many prey organisms over time, they have much higher concentrations of DDT. As you look higher and higher up the food chain, so too does DDT concentration go higher and higher in a phenomenon called biomagnification. DDT's least understood consequences arise with such long term processes and, with usage reaching tens of millions of pounds per year by the 1950s, this was a major cause for concern.



*Polar water molecule: oxygen (partially negative) in red, hydrogen (partially positive) in blue. Courtesy of Wikimedia.*

So what about in the short term? DDT works as a nerve toxin in insects and, in fact, in humans as well. In a 2021 paper, Kristopher Silver, professor of entomology at Kansas State University, investigated DDT's target within nerve cells. Nerves operate through electrical currents across cell membranes, represented by the term "action potential." These action potentials are dependent on the concentrations of sodium and potassium ions both inside and outside of the cell. In an action potential, transmembrane proteins called sodium channels open or close rapidly—in the span of milliseconds—in response to changes in sodium or potassium concentration. If the channel doesn't close incredibly quickly, ions and their associated charge build up uncontrollably leading to tremors and convulsions. This is exactly what DDT and other similar compounds do to nerve cells: "inhibit channel deactivation and inactivation, and stabilize the open state of sodium channels, causing prolonged channel opening." So how could the US government parade around declaring that DDT would solve all your problems? There are a couple reasons why DDT affects humans and insects differently. First, humans have better-

developed detoxification systems and require higher doses. But perhaps more importantly, DDT is most commonly a powder and thus can't easily undergo absorption through the skin into the body. Even small



*DDT being sprayed on children in a pool during the 1940s. Public Domain.*

doses of DDT ingested orally won't cause severe immediate danger—a misleading example that the media took and ran with.

Sure, humans weren't immediately dying from it, but the effects of DDT in the environment became evident shortly after its agricultural introduction. Prominent ornithologist Joseph Hickey observed eggshell thinning—causing eggs to break prematurely—at alarming percentages and connected it to chlorinated hydrocarbons like DDT. Though his findings were released in 1967, this thinning could be traced back to 1947. George Wallace, professor of ornithology at Michigan State University, observed birds across campus having tremors and convulsions that lead to death. He quickly published his horrifying findings a year later in 1958. As Hickey reported, bird populations were plummeting at “catastrophic” levels. Understandably, this was severely alarming to environmental groups like the Audubon Naturalist Society, which specializes in birds. Hoping to help the shocking research to gain more visibility, they sought out a young writer-researcher in Rachel Carson. Her famous book *Silent Spring*, released in 1962, skyrocketed the developing problem to the forefront of the media. Despite the extensive scientific support behind it, it received heavy criticism—especially from the producers of DDT. However, the book won over the public with its striking depictions of a bleak future: mornings previously filled with beautiful bird song

would instead become eerily silent because of the impact of pesticides on bird populations. In 1972, the United States banned agricultural use of DDT.

Despite this ban, we still face consequences of such high usage fifty years later. Luckily, some of the first studies on DDT's long term effects are providing important insight. In 2021, Michele La Merrill, professor of environmental toxicology at UC Davis, published the first three-generational study on DDT (among other toxic chemicals) in the American Association for Cancer Research Journals. It examines DDT's role in reproductive problems, obesity, and cancer. As written in a related study by La Merrill, "Many women were heavily exposed in utero during widespread DDT use in the 1960s. They are now reaching the age of heightened breast cancer risk." At the very least, the story of DDT and those impacted by it has brought a new level of scrutiny towards the use of chemicals in the environment and placed a spotlight on their long-term effects. We can't currently suck DDT out of the environment or undo its creation, but we can and must continue to research it.

In cruel, retrospective irony, Paul Hermann Müller was awarded a Nobel prize for his work with DDT and its impact at the time in 1948. The messy, devastating, and politically charged narrative that followed—which some foresaw and others chose to ignore—highlights an inescapable quality of science and its necessary companion: uncertainty and caution.



*Pelican egg  
weakened by DDT  
and crushed by the  
nesting parent.  
Courtesy of David B.  
Peakall.*

## THE USE OF TRADITIONAL CHINESE MEDICINE IN WESTERN CANCER TREATMENT

DAPHNE TANG



---

*WRITER'S COMMENT: Last year, I read the novel *The Spirit Catches You and You Fall Down* by Anne Fadiman for my Sociology of Culture and Health class. This book explores the conflict between Hmong culture and Western medicine in the United States through the story of a Hmong child with epilepsy, and her family's struggle to understand American medicine and health care system. This novel resonated with me as a child of Chinese immigrants, as my family also utilizes traditional methods to heal the body. The final report for MCB 023 allowed me to explore the idea of Traditional Chinese Medicine further, particularly its efficacy in treating cancer. As a sociology major, I researched the impacts of culturally responsive care that integrates traditional medicine, in addition to its biological effects. Though Traditional Chinese Medicine has been villainized in Western health care settings, its practices have begun to gain popularity in the United States. Integration of traditional medicine alongside Western medicine can overall help immigrant patients feel more comfortable and decrease the health disparities among immigrant populations.*

*INSTRUCTOR'S COMMENT: Instructor Comment: Throughout our time together in the Winter 2023 MCB 23 – History of Cancer, Daphne demonstrated a strong interest in developing a better understanding of the history of cancer and cross-cultural intersections between the medical experience of cancer and society. I was iteratively impressed with Daphne's inquisitive approach to the course material and how she built connections between her personal experiences with topics discussed in class.*

*Her motivation to understand the history of cancer research and treatment in Western medicine along with her knowledge and interest in traditional Chinese medicine resulted in this comprehensive research review that provides a detailed and technical synopsis of the intersection and application of traditional Chinese Medicine in cancer treatment. Daphne exemplifies the true spirit of scholarship, letting curiosity motivate the pursuit of knowledge, building connections through knowledge, and disseminating that knowledge with others.*

*-Marina Ellefson, Molecular and Cellular Biology*

## **Abstract**

Chinese-Americans face many disparities when it comes to cancer, especially among foreign-born Chinese immigrants. These are not only due to language barriers, but cultural barriers as well as the preference for the use of Traditional Chinese Medicine (TCM). Because older Chinese immigrants are used to the practices and treatment using TCM, they may distrust modern Western medicine due to its invasive and aggressive nature. TCM follows the philosophy of balance and harmony, holistically tending to the body in order to treat abnormalities. It has been shown that using it adjuvantly with modern cancer medicine can be beneficial in multiple areas, including surgery, radiotherapy, chemotherapy, as well as regulating the genes associated with cancer. The integration of TCM with Western medicine in cancer treatments can improve patient-physician relationships and increase medical compliance, leading to better health outcomes. The medical benefits of TCM are becoming more widely understood and recognized by Western medicine as clinical trials for the efficacy and safety of herbal drugs have started to take place. The following report analyzes the use of TCM in cancer treatment and how it contributes to culturally responsive care.

## **Background**

Asian-Americans are greatly impacted by cancer. Twenty-seven percent of all deaths among Asian-Americans are from cancer, and they

are the only racial group in the United States where cancer is the leading cause of death (Jun and Nan, 2018). Though there is limited research of cancer incidence among the different ethnic subgroups, it has been shown that Chinese-Americans have higher rates of liver, colorectal, stomach, and lung cancer than other Asian groups, and five-year survival rates among Chinese immigrants are lower than those among the Chinese-Americans born in the United States (Leng et al., 2012). Even within the Chinese population in the United States, there are disparities between foreign-born Chinese and American-born Chinese people, often due to stigma attached to cancer, misconceptions, limited knowledge on the disease itself, as well as lack of knowledge about how to navigate the American healthcare system (Leng et al., 2012). As one of the United States' largest and fastest growing immigrant populations, it is important to mitigate the barriers for patients who are Chinese immigrants in accessing cancer care and treatment. One way to help ease barriers is the integration of Traditional Chinese Medicine (TCM), an alternative practice focused on holistic healing, alongside modern Western treatments.

### **Cultural Barriers In Western Health Care**

Chinese patients face many cultural barriers that affect their access to and quality of cancer health care. Firstly, Chinese culture places emphasis on several qualities that Western cultures do not consider. Stoicism is believed to be a positive trait in Chinese culture, where patients endure pain and do not report it until it becomes unbearable (Tung and Li, 2014). Unawareness of the importance of stoicism in Chinese culture from health care providers may lead to the misinterpretation of what their patient is feeling and insufficient pain management. Passivity is also a trait that is often seen in Chinese patients because doctors are traditionally seen as authority figures who are not to be challenged (Leng et al., 2012). This leads to reduced health literacy among Chinese patients because they often accept what the doctor tells them to do without questioning it or fully understanding what is going on. This could also cause Chinese people to avoid the doctor altogether if they do not want to do what the doctor tells them to do. In addition, there are language and communication barriers that affect the quality of care that Chinese patients receive. Participants in a focus group study done in Chinese immigrant cancer patients in New York City described a

preference for Chinese doctors and dissatisfaction with their current ones because of the lack of understanding between them and their physicians. While some stated that they utilized interpreting services, there were many participants who were not aware that they were available. They also discussed how their doctors did not talk to them and instead just typed on their computers (Leng et al., 2012). This dissatisfaction shows how the lack of conversation and communication between the doctors and the patients creates a strained and untrusting relationship.

One of the most prevalent cultural differences in Chinese patients, especially among the elderly, is the desire for the use of TCM in treating their conditions. Many participants in the focus group study stressed the importance of expelling toxins and conditioning the body after chemotherapy, which TCM aims to do (Leng et al., 2012). There is also a prevalent fear among the Chinese community of addiction or side effects from pain medications (Tung and Li, 2014). This fear may contribute to nonadherence or the refusal to prescribed medications or treatment plans, leading to negative health outcomes. The reasons for the preference of TCM given by many Chinese elders include the minimal side effects, the emphasis on health maintenance, and the focus on eliminating health problems from the root rather than treating symptoms (Miltiades and Wu, 2008). Chinese patients often view Western health care practices and treatment as very aggressive and leading to many adverse side effects, which Chinese people want to avoid.

Ultimately, Chinese patients are not accustomed to only using Western medicine. China uses a health care system where Western medicine and traditional medicine are used simultaneously in medical settings, while the United States primarily uses a biomedical model of medicine that follows the germ theory of disease, focusing on the physical aspects of disease and treatment (Miltiades and Wu, 2008). Western health care providers rarely offer, and even discourage, the use of alternative health practices. This can be seen in the health insurance system in the United States, where alternative treatments are hardly ever covered. Western scientists often see traditional medicine as pseudoscience due to poor understanding of how it works and the lack of clinical evidence that aligns with the standards of modern science and medicine.



## **The Theories Behind Traditional Chinese Medicine**

TCM has been practiced for thousands of years, focusing on holistic treatment and the restoration of harmony and balance in the body and spirit. It follows old Chinese philosophical thinking that emphasizes the relationship between the human body and the natural environment that surrounds it. There is the belief that illness is due to the disturbance and imbalance of *Yin* and *Yang*, two opposing but interdependent forces of energy (Xiang et al., 2019). *Yin* is associated with the cold while *Yang* is associated with the heat, so an excess or a deficiency in one or the other affects the illness and symptoms that one is experiencing. In order to treat the illness, the goal of TCM is to restore the harmony of *Yin* and *Yang* (Lu et al., 2004). Similarly, there is also the Five Elements theory, also known as *Wu Xing*, where wood, fire, earth, metal, and water divides the human body into five different systems that have their own specific features (Lu et al., 2004). It describes how all aspects of human health are connected with nature, influencing our diet, movement, and emotions. Different elements are associated with different seasons, body parts and organs, and fluids. According to the Five Elements theory, when humans face health abnormalities, it is because one element either becomes too powerful or too weak, so equilibrium needs to be restored.

There are several therapeutic approaches in TCM. Methods targeted at the mind and spirit include Qigong (a system of physical exercises and breathing practices), *Tai Chi* (a martial art consisting of slow movements), and *Taiji* boxing. Natural methods include acupuncture, moxibustion (the burning of mugwort leaves), cupping therapy (muscle therapy involving suction), and herbal medicine. Because these methods are natural, they have fewer side effects (Lu et al., 2004). Compared to modern cancer treatments, such as surgery, radiotherapy, and chemotherapy, TCM commonly uses herbal medicine and treatment, as well as acupuncture and chiropractics. Over tens of thousands of herbs have been used in TCM, but common herbs that have been adopted for cancer treatment, particularly in China and in surrounding countries, include ginseng, blister beetle, toad venom, garlic, and turmeric. In the current day, remedies from herbs are often prepared using modern pharmaceutical technologies, such as injections, tablets, and pills (Ye et al. 2015).

## **Adjuvant Cancer Therapy With Traditional Chinese Medicine**

The use of TCM alongside modern cancer therapy has shown to provide many benefits in cancer patients. Specifically with Chinese herbal medicine, it has been shown to have fewer side effects, provide an enhanced quality of life, prolong survival rates, and improve immediate tumor response (Xiang et al., 2019). One of the most basic beliefs in TCM is regulating the body through “strengthening the body” and “eliminating evil” (Li et al., 2021). In order to treat cancer, strengthening the body would entail enhancing the body’s anti-cancer immunity and eliminating evil would include inhibiting tumor cell growth and metastasis.

There have been beneficial effects of adjuvant therapy with TCM after surgery. Adjuvant therapy is additional treatment given to increase efficacy. While surgery is often successful in treating localized cancers, it brings about problems, such as mood disorders, chronic pain, decreased quality of life, and other treatment-related side effects (Li et al., 2021). Acupuncture and moxibustion have been shown to help relieve dyspnea, fatigue, inflammatory responses, and shorten recovery time, while *Qigong* and *Tai Chi* can reduce mood disorders and chronic pain in patients with advanced non-small cell lung cancer (Li et al., 2021). Since surgery is such an invasive and painful procedure, TCM can help alleviate the side effects that it causes, shorten the recovery period, and improve quality of life.

The adjuvant use of TCM with chemotherapy and radiotherapy also can provide benefits and alleviate symptoms in cancer patients. The aim of chemotherapy is to induce apoptosis in cancerous cells, which can lead to adverse effects including additional gene mutation and cellular toxicity, and radiotherapy can expose noncancerous tissues to radiation. Using TCM in combination with chemotherapy and radiotherapy can enhance the response rate and sensitivity, decrease the severity of side effects, and reduce the toxicity associated with these treatments. It has been shown that using TCM alongside radiation treatment reduced the incidence of radiation xerostomia, which is a side effect that is observed in 80 percent of head and neck cancer patients receiving radiotherapy (Xiang et al., 2019). In addition, chemotherapy and radiotherapy often impairs the immune system, usually through bone marrow suppression. Herbal medicines have been shown to contain the capacity to improve functions of the immune system through enhancing the immune

response against tumors, suppressing immune inhibitory mechanisms, and shifting the immune system balance (Ye et al., 2015). Reducing the adverse effects of chemotherapy and radiotherapy with adjuvant TCM can improve therapeutic outcome and improve quality of life for cancer patients.

TCM has also shown to be effective in regulating the genes that are associated with cancer, specifically tumor suppressor genes and oncogenes. Curcumin, a naturally occurring compound in turmeric, regulates the tumor suppressor p53 protein signaling pathway by restoring its expression (Xiang et al., 2019). Because tumor suppressor genes encode for proteins to stop the cell cycle, cells will continue to divide and cause cancer if they become abnormal. Curcumin helps regulate the tumor suppressor gene so that it is able to function normally and stop cells from dividing uncontrollably. Studies have also shown that treatment with curcumin can suppress *Myc* expression in cells (Xiang et al., 2019). *Myc* is a well-recognized oncogene that causes mutated cells to divide, so suppressing it would prevent cancerous cells from dividing uncontrollably.

Prevention is another important goal of TCM. Herbal medicine has been shown to prevent cancer development and metastasis. For example, herbal therapy for precancerous disorders that possess an increased risk of cancer, such as HPV, actinic keratosis, and atrophic gastritis, have been successful in prevention. Herbal supplements that consist of quercetin, curcumin, silymarin, ginseng, and rutin, can have beneficial effects for patients with precancerous lesions of the large intestine (Ye et al., 2015). In addition, certain herbal supplements can induce cell cycle arrest or apoptosis, inhibiting cell growth and metastasis (Ye et al., 2015). Because cancer can develop from precancerous conditions, it can be beneficial to add some herbal supplements into the diet in order to prevent the progression of tumors.

### **The Importance Of Culturally Responsive Cancer Care**

In order to stress the importance of culturally responsive care, the example of Hmong Americans can be used as a case study and comparison to illustrate its positive impacts. The Hmong are an Asian ethnic group that originate from Laos, Thailand, Vietnam, and southern China. Many Hmong-Americans in the United States immigrated and

resettled as refugees after being recruited by the United States Central Intelligence Agency to fight in the Secret War as a result of the invasion of the North Vietnamese into Laos during the Vietnam War. Their culture differs greatly from Western American culture in that they traditionally believe that illnesses are primarily caused by soul loss and spirits (Parker and Neng, 1999). This causes them to have a great fear of Western health care due to their philosophy of spirituality and illness clashing with invasive Western medical tests, procedures, and surgeries. This makes the Hmong-American community a good comparison when looking at effective health care that is culturally sensitive and competent.

Figure 1 shows a table that lays out recommendations for working effectively with Asian clients, patients, and families. It advises physicians to practice conjoint treatment, where they integrate Western allopathic medicine with traditional healing arts (Parker and Neng, 1999). They then provide a case example where Western physicians and Hmong healers worked together successfully to treat Hmong patients. After the Western physician diagnosed the patient's condition, a Hmong healer was consulted and a ceremony was performed in order to release the pain. When the pain persisted, the patient accepted that it was not a spiritual problem and agreed to return to the Western physician for treatment (Parker and Neng, 1999). Western and traditional practitioners working alongside each other and integrating both types of practices will lead to increased medical adherence and better health outcomes for patients who may not trust the Western biomedical system. They are able to better avoid conflict and create a trusting relationship with their patients. If implementing culturally sensitive care is effective in a population that is even more resistant and distrusting, it can be effective in the Chinese immigrant population. Not only does TCM have health benefits in the treatment of cancer, but it can also improve compliance and engagement among Chinese-American patients when they are offered the choice of their own practices.

**TABLE 3.**  
**RECOMMENDATIONS FOR WORKING EFFECTIVELY WITH ASIAN CLIENTS/PATIENTS/FAMILIES**

---

Use trained interpreters who are both bilingual and bicultural; respect the difficult position of interpreters who are attempting to mediate between Hmong and American cultures.
Whenever possible, have female clinicians treat females and males treat males.
If surgery is necessary, seek the support of Hmong family and community leaders to ensure better outcomes.
Show either neutrality or support if the client indicates he/she is also working with a shaman or says the illness is spiritually based.
Always stress medical management rather than surgical intervention if at all possible.
Minimize the amount of blood taken for tests and minimize the number of invasive tests if possible.
Present choices to the client and make certain he/she understands the consequences of the various choices.
Allow family members to stay overnight in the hospital to protect the patient from ghosts.
Allow families to bring Hmong foods into the hospital for the patient and don't remove or inquire about the red string that Hmong often tie around their arms or necks, designed to ward off evil spirits.
Present procedures such as injections, vaccinations, and mammograms in terms of good vs. evil spirits, and the need to ward off evil spirits.
Encourage traditional Hmong arts such as weaving, music, dance, and silversmithing.
Acknowledge Hmong contributions to American military operations in Laos during the war.
Promote clan and family reunification through secondary resettlement.
Never try to undercut the father's authority within Hmong families.
Give refugees more opportunities to help themselves and make their own decisions.
Practice conjoint treatment—integrate Western allopathic medicine with traditional healing arts (Blatout & Blatout, 1999).
*Use a "little medicine and a little neeb".....the doctor cures the disease but the indigenous healer heals the illness.....conjoint treatment does more than promote trust between the doctor and the patient; because illness is so profoundly affected by psychosocial factors, it actually improves the outcome (Lee, N.K. as cited in Fadiman, 1997, pp. 265-267)

---

*Figure 1. Recommendations for Working Effectively with Asian Clients/Patients/Families. Table by Marcie Parker and Lo Neng Kiatoukaysy, December 1999.*

## **Current Perceptions and Efforts**

Despite research proving its efficacy in treating various diseases, particularly in cancer, many Westerners still hold skepticism and contempt for TCM. The primary reason why Western scientists distrust the use of traditional medicines is because they consider it to be too unreliable, illogical, and dangerous by modern biomedical standards (Zhan, 2009,105). Today, the FDA has only approved two herbal prescription drugs — genital wart treatment from green tea extract and diarrhea medicine made from the sap of dragon's blood trees (Gwin, 2019). However, Western criticism of TCM is hypocritical. The overprescription and overuse of opiates leading to the opioid epidemic and the power abuse of the pharmaceutical industry are only some notable examples of Western medicine's controversial practices. In addition, when Westerners do seek out TCM, they often are for illnesses that their Western physicians could not cure. Pang Panchi, an herbalist specializing in cancer, says that many of her patients expect too much of her, compared to what they expect from Western medicine, asking "...why should people expect overnight cures from us, when they have had the illness for years and

Western medicine could do nothing about them?” (Zhan, 2009,109). This represents the double standard that people have towards traditional medicine, where they do not have the same patience and expectations towards traditional medicine as they do with Western medicine.

Despite the current uncertainty of TCM, many of its practices are starting to gain traction among Westerners today. Cupping therapy has been used in recent years for athletes in order to reduce inflammation, increase blood flow, and perform a type of deep tissue massage. Acupuncture is becoming more popular as well, with some insurance plans beginning to cover it. There has also been growth in the use of herbal remedies because they are cheaper than prescribed pharmaceuticals (Gwin, 2019). Though there has not been much widespread use of TCM in the treatment of cancer, some clinical studies are beginning to research the use of herbal drugs in clinical settings. Yale pharmacologist, Yung Chi Cheng, has launched an international clinical trial in 2020 for a botanical drug, YIV-906, for patients with liver cancer and hepatitis B. So far, YIV-906 has reduced the toxic gastrointestinal side effects of chemotherapy drug CPT-11, also known as irinotecan, and enhanced its anti-tumor activity (Belli, 2020). If this trial is successful and receives FDA approval, it could push TCM to the forefront and show its potential for treating not only cancer, but other diseases as well.

### **Conclusion**

The integration of Traditional Chinese Medicine with modern cancer treatment would improve the health disparities faced by Chinese immigrant cancer patients as culturally competent care has been shown to do in other cases. As cancer is the leading cause of death among Asian-Americans, it is of the utmost importance to mitigate the barriers that prevent them from accessing the type of care that they need. With the practices and remedies of TCM gaining popularity in the West and herbal drugs going through biomedical clinical trials, Western physicians may start providing the option of adjuvant TCM into the cancer treatment of not only their Chinese patients, but patients of any background who may want it. Though Western biomedical standards are not the only and most important to follow and consider, studying TCM in a biomedical setting may improve the attitudes that Western scientists may have towards it.

The acceptance of TCM may also eventually lead to the

acceptance of other forms of alternative cultural medicines, such as those originating from different African cultures or those that are practiced among Indigenous American populations. Alongside multicultural medicine, the expansion of language translation and the use of cultural brokers in health care settings must be implemented in order to most effectively address the health problems of cultural minorities, especially those who are at an increased risk for cancer and other illnesses. This will improve health outcomes for marginalized communities who lack knowledge and understanding of modern medicine and have difficulty navigating Western health care settings. The practice of multicultural medicine and culturally responsive care will not only benefit people of one culture, but can further medical knowledge and improve health outcomes for everyone as it opens the door for new methods and techniques.

## **Works Cited**

- Belli, B. 2020. "Ancient Chinese Medicine Unlocks New Possibilities for Cancer Treatment." *YaleNews*. March 13, 2020. <https://news.yale.edu/2020/03/13/ancient-chinese-medicine-unlocks-new-possibilities-cancer-treatment>.
- Gwin, P. 2019. "How Ancient Remedies are Changing Modern Medicine." *National Geographic*. January 5, 2019. <https://www.nationalgeographic.com/magazine/article/ancient-chinese-remedies-changing-modern-medicine>.
- Jun, Jungmi, and Xiaoli Nan. 2018. "Determinants of Cancer Screening Disparities Among Asian Americans: A Systematic Review of Public Health Surveys." *Journal of Cancer Education* 33 (4): 757–68. <https://doi.org/10.1007/s13187-017-1211-x>.
- Leng, Jennifer, Trevor Lee, Umut Sarpel, Jessy Lau, Yanjun Li, Connie Cheng, Ming-der Chang, and Francesca Gany. 2012. "Identifying the Informational and Psychosocial Needs of Chinese Immigrant Cancer Patients: A Focus Group Study." *Supportive Care in Cancer* 20 (12): 3221–29. <https://doi.org/10.1007/s00520-012-1464-1>.
- Li, Zhang, Zhang Feiyue, and Li Gaofeng. 2021. "Traditional Chinese Medicine and Lung Cancer——From Theory to Practice." *Biomedicine & Pharmacotherapy* 137 (May): 111381. <https://doi.org/10.1016/j.biopha.2021.111381>.
- Lu, Ai-Ping. 2004. "Theory of Traditional Chinese Medicine and Therapeutic Method of Diseases." *World Journal of Gastroenterology* 10 (13): 1854. <https://doi.org/10.3748/wjg.v10.i13.1854>.
- Miltiades, Helen B., and Bei Wu. 2008. "Factors Affecting Physician Visits in Chinese and Chinese Immigrant Samples." *Social Science & Medicine* 66 (3): 704–14. <https://doi.org/10.1016/j.socscimed.2007.10.016>.



- Parker, Marcie, and Lo Neng. 2007. "Culturally Responsive Health Care: The Example of the Hmong in America." *Journal of the American Academy of Nurse Practitioners* 11 (12): 511–18. <https://doi.org/10.1111/j.1745-7599.1999.tb01220.x>.
- Tung, Wei-Chen, and Zhizhong Li. 2015. "Pain Beliefs and Behaviors Among Chinese." *Home Health Care Management & Practice* 27 (2): 95–97. <https://doi.org/10.1177/1084822314547962>.
- Xiang, Yuening, Zimu Guo, Pengfei Zhu, Jia Chen, and Yongye Huang. 2019. "Traditional Chinese Medicine as a Cancer Treatment: Modern Perspectives of Ancient but Advanced Science." *Cancer Medicine* 8 (5): 1958–75. <https://doi.org/10.1002/cam4.2108>.
- Ye, Lin, Yongning Jia, Ke Ji, Andrew J. Sanders, Kan Xue, Jiafu Ji, Malcolm D. Mason, and Wen G. Jiang. 2015. "Traditional Chinese Medicine in the Prevention and Treatment of Cancer and Cancer Metastasis." *Oncology Letters* 10 (3): 1240–50. <https://doi.org/10.3892/ol.2015.3459>.
- Zhan, Mei. 2009. *Other-Worldly: Making Chinese Medicine Through Transnational Frames*. Durham: Duke University Press.

## A REVIEW OF ALGAE IN SPACE FOR FUTURE LIFE SUPPORT SYSTEMS

ISAAC YU



---

*WRITER'S COMMENT: When I started looking for research opportunities at UC Davis, I was introduced to the McDonald and Nandi lab. After poking around their website, I saw that they worked with NASA in a research program called CUBES which develops biological, renewable resources to support deep space exploration. The idea of using plants to provide oxygen and food to sustain life on other planets immediately fascinated me and inspired this paper. I began my research by studying how scientists use algae as a resource in space due to its adaptability. However, recent research shows that using plants as a renewable source of oxygen in space is a novel field. We need more insight in the survivability of algae in space before algae can be fully incorporated in space expeditions. For this reason, I wanted to write a review that documents progress in research and shows where different areas need work. I hope this review inspires others to seek out creative solutions for tough problems.*

*INSTRUCTOR'S COMMENT: When Isaac chose to research biological life support systems for space travel for UWP 102B Writing in the Biological Sciences, I was as excited as he was to learn about this topic. Isaac found that researchers were exploring the potential of algae, and he subsequently decided to focus on the stressors algae might face in space. Isaac's published review showcases his work throughout the term: expanding and narrowing his research focus, revising and editing sentences and paragraphs, and making decisions about sources. Because of this work, Isaac's final topic and review are clear and simple, but the implications are complex and far reaching. His review highlights*

*the idea that achieving a grand human endeavor, such as reaching Mars, requires many small moments of exploration and discovery here on Earth, and Isaac has done a great job of introducing readers to one of those small moments.*

*—Amy Goodman-Bide, University Writing Program*

Technology has progressed since the first moon landing and humans may be able to reach Mars as early as the year 2030 (NASA 2020). One such technology includes life support systems that provide oxygen for astronauts and remove carbon dioxide from the air aboard the International Space Station (ISS). However, current life support systems are limited because they require supplies to be sent from Earth to the ISS to be maintained (NASA 2017). Resupply missions are costly because of limited cargo space and can cost as much as 14 billion dollars (Sahinkaya and Kim 2018, NASA 2022). To solve this resupply problem, researchers have proposed biological life support systems (BLSS) as a solution. A BLSS would harness the biological processes of microorganisms, like photosynthesis, to create a regenerative source of fresh air, water filtration, and food for astronauts (Liu et al. 2021).

One microorganism researchers are interested in is algae because algae are easy to grow, can survive inhospitable conditions, and have an edible biomass (Strauch et al. 2018, Babich et al. 2022). Before algae can be implemented in a BLSS, however, researchers have to understand how algae can grow in space-like conditions in order to design a BLSS that accounts for these conditions. The stresses algae will face in space include solar and UV radiation, low-pressure environments, and being stored in containers for extended periods of time (Abercromby et al. 2020, NASA 2019, Strauch et al. 2018). This review will discuss how algae physically respond to these environmental stresses over short periods of time. By simulating space-like environments in laboratories and the Earth's

atmosphere, we can analyze how algae respond and determine if they are suited for growth in space. This review will also explore how algae genetically respond to these stresses and identify genes of interest for future research. By doing so, we can identify aspects of a BLSS that need to protect algae in space and direct future studies to create strains of algae suited for BLSS through genetics.

### **Algal Photosynthesis Versus UV Light And Radiation**

According to NASA, astronauts in space are exposed to about .05 to 20 grays (units of radiation) of ionizing radiation (NASA 2019). Algae will face similar amounts of solar, ion, and UV radiation if they are cultivated in space. These types of radiation are dangerous for algae because radiation can damage photosynthetic systems, destroy DNA, and cause detrimental mutations (Piccini et al. 2020, Vitale et al. 2022). To study the effect of ion radiation on algae, researchers irradiated the algae *S. quadricauda* with 20 and 60 grays of carbon ions and cultured the algae for 48 hours afterwards (Wang et al. 2018). The results show that two hours after exposure, algae irradiated with 60 grays had decreased photosynthetic activity compared to non-irradiated algae. After 48 hours from exposure, however, algae exposed to 60 grays recovered photosynthetic activity to the level of the control group. Researchers also found that the algae exposed to 20 grays of radiation had no overall difference in photosynthetic activity compared to the control group. Although these results indicate algae can survive and have efficient photosynthesis in the radiation astronauts will face in space at 20 grays, *S. quadricauda* was only briefly exposed to carbon ion radiation. Future studies should explore how long-term exposure to radiation will affect algae's growth, photosynthesis, and adaptation.

In space, algae will also face UV light and its detrimental effects. To study how UV light affects algal photosynthesis in spacelike conditions, Wang et al. (2021) sealed *Chlorella* algae in Petri dishes and used a high altitude balloon to the algae 31

kilometers above the Earth's sea level for four hours. During flight, one group of algae was exposed to light and the other group was kept in darkness. Another group of algae was grown at ground level in darkness as a control group. After flight, all groups of algae were grown for 12 days and their activity was measured. The results show that the flight group exposed to light had the lowest cell growth, photosynthetic activity, and the highest cell mortality rate among every group. In contrast, the flight group that was covered in darkness had no difference in photosynthetic activity or population growth compared to the control group. Wang et al. demonstrated how UV light hinders algal growth and photosynthesis more than temperature, air pressure, or other conditions in space. Since algae can survive normally without UV light, future studies should focus on building a BLSS which protects the algae from UV light.

### **Algal Growth Versus Low Air Pressure**

Other factors algae will face in space include low-pressure environments in space vehicles. Since NASA has directed space vehicles to have cabin pressures at half of Earth's atmospheric pressure (Abercromby et al. 2020), researchers have to study how algae grow in low-pressure conditions before using algae in a BLSS. To study this, researchers cultivated the algae *C. vulgaris* in a vacuum-sealed growth chamber in six trials, with each trial lasting a week (Niederwieser et al. 2019). The growth chamber's air pressure was lowered to half of Earth's atmospheric pressure by removing nitrogen gas and keeping oxygen and carbon dioxide levels constant. The data collected showed that *C. vulgaris*' growth and carbon dioxide uptake were not affected when grown in half of Earth's atmospheric pressure. These results show algae can grow successfully in low-pressure conditions and have the potential to be cultivated in space. Research done by Cycil et al. (2021) showed similar outcomes as well. In this study, researchers grew five different strains of algae in pure carbon dioxide gas at 670 mbar (about 67% of Earth's air pressure at sea level), 330, 160, and 80 mbar in a

vacuum-sealed container for 33 to 62 days. The results show that at 670 mbar, the algae *C. brevispina*, *D. salina*, and *C. vulgaris* all grew to population sizes similar to their growth at Earth's atmospheric pressure. Researchers also found that the carrying capacity (the highest population of organisms that an environment can sustain) of *C. vulgaris* increased as pressure decreased throughout the study (Cycil et al. 2020).

While Cycil et al. and Niederwieser et al. used different methods of lowering air pressure, both studies show evidence that algae can be grown effectively at half of the Earth's atmospheric pressure. Research done by Wang et al. (2021) also supports the conclusion that algae can grow effectively in low-pressure environments. However, both Cycil et al. and Niederwieser et al. studied algae over relatively short periods of time compared to the length of space exploration missions, which can last up to 340 days (NASA 2020). Future research should study how algae grow in low-pressure conditions over long periods of time to ensure the algae in life support systems will survive and provide enough oxygen for a crew of astronauts. The algae *C. vulgaris* may be a candidate for these long-term experiments in low pressure because *C. vulgaris* has shown it can adapt to low-pressure conditions over time and thrive (Cycil et al. 2020).

### **Other Considerations And Genetic Responses In Algae**

One way researchers can study algae for use in space exploration is to look at how algae genetically respond to stresses in space. This way, researchers can target specific genes in algae and create new strains of algae which are resistant to environmental stresses. Another stress to consider for algae in space is long periods of storage during transportation. Since species of algae can stay in a dormant state during inhospitable conditions and be revitalized (Terlova, Holzinger, Lewis 2021), researchers want to store algae in dormancy for later recovery in space expeditions. A study done by Strauch et al. (2018) looked at how the algae *E.*

*gracilis* genetically responded to being stored in a dormant state to simulate transportation during space exploration. The algae were first dried out and kept at 20 degrees Celsius in wet mineral medium and low lighting for 9 months. To revitalize the algae after storage, the researchers rehydrated the algae in mineral media with optimal amounts of fluorescent light. The results show that during recovery from dormancy, *E. gracilis* had increased levels of heat-shock proteins (HSPs), which protect other proteins from misfolding, preserve signaling pathways within the cell, and activate other repair proteins (Dubrez et al. 2019). Future research should focus on understanding the genes and pathways which create HSPs in order to enhance these genes and increase algae's survivability. Another study done by Zhang et al. (2020) also looked at algae growth during storage conditions and found that the algae had increased levels of proteins related to DNA repair, protein creation, and signal transduction. These results, along with the results from Strauch et al., show that genes related to repairing cell function and cell signaling are important for algae's survival and should be studied as well.

Previously mentioned studies also used genetic analysis to understand how algae responded to stresses in their environments. Both Wang et al. (2018) and Wang et al. (2021) found that algae upregulate genes associated with thermal dissipation, antioxidant protection, heat-shock proteins, and DNA repair in response to radiation and UV light. Genes involved with DNA repair and heat-shock proteins are a common trend in algae facing space-like environmental stresses. If researchers can understand how these genes and their associated pathways aid algae's response to stresses, then they can create strains of algae with enhanced versions of these genes that are resistant to dangers from the environment. Future research should also investigate the metabolic molecules algae need to produce DNA repair and heat-shock proteins. This way, researchers can supplement algae's nutritional intake with the needed metabolic molecules and ensure functional genetic pathways.

## **Conclusion**

Researchers study algae because of their potential use as a regenerative life support system for astronauts in space exploration. Several studies have shown how algae can grow well and even adapt to the low-pressure conditions of space, but algae are still susceptible to photosynthetic damage from UV light. Future designs for a BLSS using algae should emphasize protection against radiation and UV light to protect algae's photosynthetic systems from damage. Genetic analysis has also shown that damage from radiation, UV light, and growth in storage has caused algae to upregulate the production of heat-shock proteins and DNA repair proteins. Genes and biological pathways which create heat shock and DNA repair proteins should be studied in order to modify these genes and enhance the survivability of algae.

However, most of the studies in this review used simulated conditions in laboratory settings to study algae over short periods of time. Future research needs to focus on the long-term growth of algae aboard shuttles or the International Space Station in zero-gravity environments to understand if algae will adapt or eventually die out over time. Most studies also looked at the effects of one stress on algae instead of multiple stresses. Additional research is needed to understand how algae respond to multiple stresses at the same time so researchers can design a sustainable and reliable life support system for space exploration.



## **References:**

6 Technologies NASA is advancing to send humans to Mars . 2020. Houston (TX): NASA; [updated Jul 20, 2020; cited Nov 15, 2022]. Available from: [https://www.nasa.gov/directorates/spacetech/6\\_Technologies\\_NASA\\_is\\_Advancing\\_to\\_Send\\_Humans\\_to\\_Mars](https://www.nasa.gov/directorates/spacetech/6_Technologies_NASA_is_Advancing_to_Send_Humans_to_Mars)

Life support systems | NASA . 2017. Houston (TX): NASA; [updated Aug 3, 2017; cited Dec 9, 2022]. Available from: <https://www.nasa.gov/content/life-support-systems>

Sahinkaya T, Kim S. 2018. International space station resupply cost minimization. In: editors. IIE Annual Conference; 2018; Texas. Norcross, Georgia (GA): Institute of Industrial and Systems Engineers. p. 360-365.

NASA Orders Additional Cargo Flights to Space Station | NASA . 2022. NASA; [updated Mar 25, 2022; cited Nov 15, 2022]. Available from: <https://www.nasa.gov/feature/nasa-orders-additional-cargo-flights-to-space-station>

Liu H, Yao Z, Fu Y, Feng J. 2021. Review of research into bioregenerative life support system(s) which can support humans living in space. *Life Sciences in Space Research*. [accessed Nov 15, 2022]; 31:113-120. doi: 10.1016/j.lssr.2021.09.003

Strauch SM, Becker I, Pölloth L, Richter PR, Haag FWM, Hauslage J, Lebert M. 2018. Restart capability of resting-states of *Euglena gracilis* after 9 months of dormancy: preparation for autonomous space flight experiments. *International Journal of Astrobiology*. [accessed Nov 15, 2022]; 17(2):101-111. doi: 10.1017/S1473550417000131

Babich O, Sukhikh S, Larina V, Kalashnikova O, Kashirskikh E, Prosekov A, Noskova S, Ivanova S, Fendri I, Smaoui S, et al. 2022. Algae: study of edible and biologically active fractions, their properties and applications. *Plants*. [accessed Nov 15, 2022]; 11(6):780. doi: 10.3390/plants11060780

Abercromby AFJ, Bekdash O, Cupples JS, Dunn JT, Dillon EL, Garbino A, Hernandez Y, Kanelakos AD, Kovich C, Matula E, et al. 2020. Crew Health and Performance Extravehicular Activity Roadmap: 2020 [Internet]. Houston (TX): NASA; [cited Nov 15, 2022]. Available from: <https://ntrs.nasa.gov/citations/20205007604>

Why space radiation matters | NASA . 2019. Houston (TX): NASA; [updated Oct 8, 2019; cited Dec 9, 2022]. Available from: <https://www.nasa.gov/analogs/nsrl/why-space-radiation-matters>

Piccini C, Cai G, Dias MC, Romi M, Longo R, Cantini C. 2020. UV-B radiation affects photosynthesis-related processes of two Italian *Olea europaea* (L.) varieties differently. *Plants*. [accessed Nov 15, 2022]; 9(17):1-21. doi: 10.3390/plants9121712

Vitale E, Izzo LG, Amitrano C, Velikova V, Tsonev T, Simoniello P, Micco VD, Arena C. 2022. Light quality modulates photosynthesis and antioxidant properties of *B. vulgaris* L. *Plants* from seeds irradiated with high-energy heavy ions: implications for cultivation in space. *Plants*. [accessed Nov 15, 2022]; 11(14):1-18. doi: 10.3390/plants11141816

Wang J, Wang J, Li W, Luo G, Yang S, Du Y, Wei W, Jin W, Luo S, Li X. 2018. Photosynthetic response of *Scenedesmus quadricauda* to carbon ions irradiation. *Acta Astronautica*. [accessed Nov 15, 2022]; 159(4):27-32. doi: 10.1016/j.actaastro.2018.12.013

Wang B, Ye T, Li X, Bian P, Liu Y, Wang G. 2021. Survival of desert algae *Chlorella* exposed to Mars-like near space environment. *Life Sciences in Space Research*. [accessed Nov 15, 2022]; 29(4): 22-29. doi: 10.1016/j.lssr.2021.02.003

Niederwieser T, Kociolek P, Hoehn A, Klaus D. 2019. Effect of altered nitrogen partial pressure on Chlorellaceae for spaceflight applications. *Algal Research*. [accessed Nov 15, 2022]; 41(101543):1-11. doi: 10.1016/j.algal.2019.101543

Cytil LM, Hausrath EM, Ming DW, Adcock CT, Raymond J, Remias D, Ruemmele WP. 2021. Investigating the growth of algae under low atmospheric pressures for potential food and oxygen production on Mars. *Frontiers in Microbiology*. [accessed Nov 15, 2022]; 12(733244):1-9. doi: 10.3389/fmicb.2021.733244

Space-station 20th: long-duration missions [Internet]. 2020. Houston (TX): NASA; [updated Mar 2, 2020; cited Dec 10, 2022]. Available from: <https://www.nasa.gov/feature/space-station-20th-long-duration-missions>

Terlova E, Holzinger A, Lewis L. 2021. Terrestrial green algae show higher tolerance to dehydration than do their aquatic sister-species. *Microbial Ecology*. [accessed Nov 15, 2022]; 82:770-782 doi: 10.1007/s00248-020-01679-3

Dubrez L, Causse S, Bonan NB, Dumétier B, Garrido C. 2020. Heat-shock proteins: chaperoning DNA repair. *Oncogene*. [accessed 2022 Nov 10, 2022]; 39:516-529. doi: 10.1038/s41388-019-1016-y

Zhang J, Müller BSF, Tyre KN, Hersh HL, Bai F, Hu Y, Resende MFR Jr, Rathinasabapathi B., Settles AM. 2020. Competitive growth assay of mutagenized *Chlamydomonas reinhardtii* compatible with the international space station veggie plant growth chamber. *Frontiers in Plant Science*. [accessed Oct 27, 2022]; 11(631):1-14. doi: 10.3389/fpls.2020.00631

## DENGUE: THE MOST COMMON ARBOVIRUS IN THE WORLD

TAN N. HUA



---

*WRITER'S COMMENT: After taking a Human Virology course taught by the UC Davis School of Medicine, my fascination with studying viruses grew as I learned more about the medical applications and treatments available to prevent transmission in modern society. I have been grateful to conduct research within the UC Davis Level 1 Trauma Center (emergency medicine) as well as in Dr. Aldrin V. Gomes' laboratory of physiology/membrane biology, broadening my experiences in medicine which led to taking this course in Medical Entomology taught by Dr. Geoffrey Attardo. When the class was assigned a report on a specific vector-borne disease, my immediate response was to write about Dengue fever, the most common arboviral infection in the world from memory. Given its widespread transmission, it is vital to have a foundation of how to prevent/treat it today. As a prospective physician and after writing this essay, I became a learning assistant for the UCD SOM Human Immunology course to solidify my experience and share how this Dengue report shall give credible, firsthand knowledge on self-care and prevention.*

*INSTRUCTOR'S COMMENT: In this essay, Tan Hua masterfully addresses the challenge of Dengue Fever in global human populations with a detailed plan developed for a Medical Entomology assignment. Tan explores dengue's history, distribution, and potential expansion due to global warming while analyzing the mosquito vector's biology, control measures, and the virus. The essay presents clear methodologies for vector control, virus detection, vaccine development, epidemiological surveillance, and public health interventions. Hua's comprehensive*

*approach to raising public awareness empowers individuals and informs policymakers, making the essay informative and actionable. Enhanced by vivid figures clarifying complex concepts, Hua's essay is a prime example of excellence in scientific communication.*

*—Geoffrey Attardo, Department of Entomology and Nematology*

An in-depth analysis of Dengue Fever public health response & management methods in California and beyond, with an emphasis on the UC Davis Dengue Relief Foundation

**Keywords:** *Dengue fever, Dengue hemorrhagic fever, Dengue virus, vector-borne disease, Aedes mosquito, Dengue Relief Foundation, Dengue education sessions, Dengvaxia® vaccine*

Dengue fever is a vector-borne disease primarily caused by an arthropod-borne virus (arbovirus) transmitted by the *Aedes* mosquito species [3]. The WHO reported in 2022 that this disease has globally and rapidly spread from 505,430 cases in 2000, to over 2.4 million in 2010, and 5.2 million in 2019. Moreover, the number of deaths between 2000 and 2015 increased from 960 to 403 where in those cases, patients have been witnessed to develop severe dengue, a condition that gives rise to numerous complications such as organ impairment, hemorrhagic fever, and death [8]. More locally, a recent report by the California Department of Public Health on February 1, 2023 revealed a total of 71 cases of travel-associated Dengue virus (DENV) infections in California with counties such as Sacramento, Yolo, and Contra Costa County being affected

[7]. This brings into question how current cases of Dengue fever could be managed and prevented in both California and global areas using methods and funding provided by WHO. In order to initiate this, the main problems to consider are (1) the history, impact on society, and epidemiology of the disease, (2) the arthropod vector and how to detect/control it, (3) the pathogen and also how to detect/control it, (4) the disease's semiology and treatment options, and (5) the necessary public health prevention and education measures to take. All in all, the main purpose of this WHO research proposal is to create long-lasting Dengue control and prevention plan within the Northern California region that can provide the necessary steps against the vector and pathogen, and identify vulnerable global population regions affected by income and healthcare disparity in order to successfully apply this plan in other countries.

## **I. History, Impact, & Global Epidemiology**

### History & Human Impact

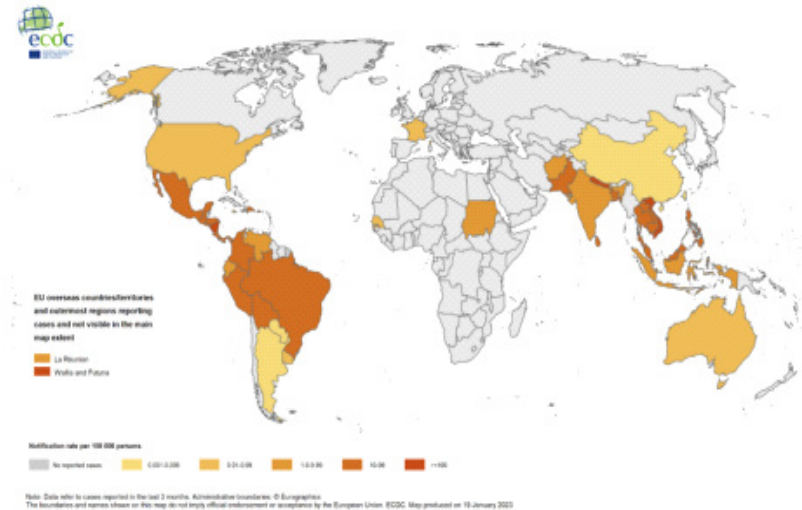
The first mention of dengue fever was during the Chinese Jin Dynasty (AD 265-420) when it was first referred to as “water poison” and eventually discovered to be associated with flying insects in a Chinese medical encyclopedia dating AD 992 [16]. The same report also states that the first official clinical case was reported between 1789 and 1790, when an epidemic arose in Philadelphia and was first called “break bone fever” because its symptoms involved muscle and bone inflammation plus seizure. Eventually, it was consequently stated in the same study that the word “dengue” was used to describe the fever, where the word is derived from the Swahili language which meant “cramp-like seizure.” Dengue fever has been known to have a notorious history with harmfully associated impacts by creating

outbreaks and epidemics for not just human life, but also animal life, where animals can serve as reservoirs of the disease after it was recently detected in tropical and sub-tropical animals such as bats (10.1%), non-human primates (27.3%), birds (11%), bovid (4.1%), dogs (1.6%), horses (5.1%), pigs (34.1%), rodents (3.5%), marsupials (13%) and other small animals (7.3%) [17].

### Current Global Distribution

Currently, a global report in January 2023 states a total of 4,110,465 cases and 4,099 deaths in the year 2022, mentioning that the countries with the most recent outbreaks are Brazil (2,363,490 cases; 991 deaths), the Philippines (220,705; 722), Vietnam (367,729; 140), Indonesia (125,888; 1,082), and India (110,473; 86) [11]. Meanwhile, a United States report in August 2022 states the most recent local outbreaks occurred in Texas (2013), Florida (2013 & 2020), & Hawaii (2015) [10]. From a local perspective, the California Department of Public Health illustrated a distribution map of the responsible vector, the *Aedes* mosquito species, showing the *Aedes aegypti* species listed as present in all cities of the Sacramento County (Carmichael, Citrus Heights, Elk Grove, Fair Oaks, Orangevale, Rio Linda, Sacramento) and Yolo County (Davis, Winters, Woodland), some cities having the *Aedes albopictus* species as well [7].





**Figure 1. Global distribution map of reported Dengue fever incidents, Oct-Dec 2022 [11] *Geographic Control of Disease Transmission***

The primary focus of controlling efforts globally shall take place in the five previously mentioned countries in order to have the maximum impact on disease transmission. The reason behind this is that Dengue fever has been illustrated to create infection rates around the warm temperature value of 28 °C, which falls within the optimal range for the *Aedes* mosquito egg to survive (22–34°C) and the range which mosquitoes can best fly (15–32°C), all of which fall within the average climate temperatures of Brazil (25.58°C), the Philippines (26.6°C), Vietnam (25.03°C), Indonesia (25.99°C), and India (24.99°C)[2] [3] [28]. These five countries also lie within the tropical and subtropical regions of the world, furthering the suggestion that the main focus shall be on applying Dengue control and prevention strategies in these places to maximize the effect and accurately reflect the current global infection and mortality rates.

### Effects of Climate Change on Distribution

It is predicted that climate change will lead to the effects of increasing vector and pathogen reproduction rates, increased disease transmission, and increased range of spread due to an increase in global temperature and humidity [28]. Therefore, this shall lead to a wider distribution of the disease, presenting the need for this research proposal to take into account how climate change could affect any chosen control and prevention strategies in the future. In regions with extreme ambient heat, this climate was associated with short-term reduced dengue transmission, addressing the short-term effects of climate change on transmission when dengue outbreaks are considered common in the tropics [26]. Furthermore, the *Aedes* mosquito vector has been capable of maturing quicker and making the DENV replication phase shorter, leading to faster transmission rates due to adaptation and also opening the possibility of vectors and DENV to expand their travel range into cold regions that are now warmer [21].

## **II. Vector Biology & Control**

### Arthropod Vector: *Aedes* mosquito

Dengue fever is mainly carried by mosquitoes as the vector, particularly the genera *Aedes* mosquito of the Culicidae family [3]. The two species reported to carry DENV are *Aedes aegypti* and, less significantly, *Aedes albopictus* [8]. This species' ecological role is discovered to act as a pollinator for plants and a sustainable food source for predators such as birds and prey, making the idea of eradicating mosquito species

implausible for the environment as a whole [18]. On the other hand, mosquitoes tend to live near humans and animals that act as their primary food source, which is when they exhibit biting behavior to collect blood and nutrients from the skin [16]. In terms of its living patterns, the general life cycle of the *Aedes* mosquito is as follows: (1) when a mosquito egg is laid above water, the larvae develops maturity, then (2) the adult mosquito emerges from the matured pupa structure and is capable of flying and mating, then (3) the mosquito collects blood from a host as its necessary nutrient for egg production and development [1] [5].

#### Assessment of Vector Control Techniques

A current surveillance system called the Dengue Relief Foundation by the University of California, Davis Medical Center is a currently active program made by Dr. David Copenhaver that uses satellite imagery of a third-world country town. This imagery allows public health workers to identify areas with high indices of mosquito infestation and interpret spatial relationships of areas with potential larval development sites (e.g., garbage piles, bodies of standing water) [30]. With consideration, this program may be replicated to survey the Northern California region by focusing on areas suitable for *Aedes* mosquito growth and development such as the examples described. This method can be determined successful if trends appear based on county and environmental factors (e.g., humidity, temperature), where mosquitoes theoretically thrive in warmer and more humid climates. Additionally, the use of *Wolbachia*, an intracellular bacteria, as an approach has also proven effective that the World Mosquito Program has launched a non-profit initiative using *Wolbachia* to reduce the *Aedes* mosquito from being a successful vector in regions such as Asia, the Americas, and

Oceania, now reported having protected more than 10 million people worldwide in 2022 [15].

### **III. Pathogen Biology & Detection**

#### Pathogen Species: Virus

Dengue fever is caused by the pathogenic agent literally called the “Dengue virus,” (DENV) belonging to the family Flaviviridae which consists of a natural, spherical shape. Biologically, it is detailed to have four serotypes that spread after a carrier mosquito bite, commonly infecting Langerhans skin cells and damaging epithelial cells that cause blood vessels to leak, also alerting dendritic cells to initiate an immune response [4]. The four different serotypes are also said by the same literature to create a variety of symptoms from inflammation to severe shock known caused by Dengue hemorrhagic fever or shock syndrome [24]. Human Pathogen Detection & Diagnosis

Within affected human populations, early detection can be done by using rapid diagnostic testing and properly identifying the necessary symptoms in a clinical diagnosis. According to the Centers for Disease Control and Prevention, current tests that exist for humans are (1) the nucleic acid amplification test (NAAT) which looks for the presence of rRT-PCR or NS1 antigen after

infection, (2) the serologic test which looks for immunoglobulin-M (IgM) antibody, and the ELISA test which detects IgG [12]. For detection, these testing methods can be implemented to cover enough of the Northern California population by providing sufficient funding to make and distribute tests to the general public. One significant challenge is developing a test with high enough sensitivity

to accompany current prevention strategies and provide early warning of an epidemic, which is why the main goal of this prevention strategy is to create the most sustainable rapid diagnostic test (RDT) for the public to access and to accompany/not create side effects with additional prevention strategies such as vaccination. A 2021 clinical trial tested a new WHO-approved rapid test called Excivion Dengue RDT, which has a successful high specificity rate (>98% and 100% respectively) and sensitivity (>93%) making it suitable to determine prior DENV infection and suitability for vaccination using Dengvaxia®, a licensed dengue vaccine [13]. With this test, it is effective enough to accompany vaccination strategies against DENV and also be both quick and accurate enough to detect and diagnose the virus in human populations.

#### **IV. Symptomology & Treatment**

##### Alerting Local Populations & Receiving Medical Care

Once symptoms are present in a noticeable amount of individuals, it is important to alert local officials of the presence of Dengue fever in the Northern California region. This may be done by directly contacting the California Department of Public Health and contacting healthcare facilities such as UC Davis Medical Center and Sutter Health to introduce a care plan to put in place in the event that a Dengue outbreak occurs. As a result, it is crucial to address how to treat underserved populations potentially affected by DENV who may face socioeconomic barriers to receiving proper care (e.g., low income & resources, differences in cultural medical practices). With RDT and the use of medications to treat Dengue as a Western medicine practice, it is important to address how the WHO should create

tailored treatment plans to provide care to Eastern medical and non-practicing individuals, where one primary example is a 2020 clinical case study showing the effect of Chinese herbs (*Oaeibua suffruticosa*, Zhu Ye Shi Gao Tang, etc.) being capable of treating Dengue fever [6]. This also creates the need for more research on what primary care methods are accessible in Northern California regions and worldwide in order to confirm what treatments are available and most accessible depending on location. In terms of providing economic relief to overcome income disparity, this research proposal shall garner the necessary funding from WHO to make this a non-profit plan to distribute cost-effective rapid testing kits and vaccinations to the public so that these resources are free to the public regardless of location. Clinical Treatment: Vaccination as Prevention & Elimination of Pathogen As a prime method of prevention, clinical trials within the past two years have instituted the distribution of an official Dengue vaccine to the general public. More specifically, the Dengvaxia® vaccine along with newer brands have shown trustworthy results in third-world countries but with limitations. The Dengvaxia® vaccine was discovered in a 2020 global development update to be less effective against serotype II (DENV2) than others, leading to the aim for creating a new vaccine that could overcome this issue [23]. With these newly made vaccines in mind, the goal is to reach out to pharmaceutical companies providing these branded vaccines and see which one(s) are available to use in this control and prevention plan. In doing so, the vaccine will then be capable of eliminating the pathogen in the early stages of infection and reducing mortality rates.

### Clinical Treatment: Mitigation of Symptoms

There is no specific treatment for eradicating DENV; however there are treatments to mitigate symptoms and

control bodily process, where it is recommended to (1) treat the symptom of dehydration by drinking more fluids and (2) treat inflammation/aching by taking over-the-counter acetaminophen while avoiding other medications such as aspirin, ibuprofen, and naproxen sodium [9] [14]. In more severe cases such as Dengue hemorrhagic fever, antihistamines such as rupatadine have proven effective at reducing the incidence rate as seen in patients in a randomized, double-blind, placebo-controlled trial [19]. Within the immune system is another possibility of lessening the degree of the body's immune response by targeting B cells and lymphoid cells (hILCs) to lessen inflammation severity [22]. Overall, this is the main care needed to treat and mitigate symptoms of people infected with Dengue because the virus itself infects host cells and uses their nutrients to repeat its life cycle.

## **V. Public Health Education & Prevention Measures**

### Public Health Educational Outreach: Communicating with Policymakers

With a more thorough understanding of the global distribution, vector, pathogen, and pathology of DENV, it is time to address the vital public health education strategies using scientific literature to educate and prevent Dengue fever. The WHO shall enforce the act of promoting public health education and outreach to regions such as Northern California and globally such as the areas of anticipated maximum impact: Brazil, Indonesia, the Philippines, India, and Vietnam. For Dengue fever, the key information required to empower policymakers and the public is to assess what strategies are self-sustainable, economic and environment-

friendly, and trustworthy for institutions to follow. Putting a control and prevention plan into effect that follows this criterion shall allow the rates of infection to significantly reduce and efficiently provide treatments for existing infections on a global scale. For policymakers specifically, information regarding what public health policies and political suggestions to make shall be communicated specifically. With regards to the proposal, the plan of creating a Dengue surveillance system which consists of satellite imagery and case reporting shall be communicated along with the statement of making it a nonprofit plan under the Nonprofit Public Benefit Corporation Law similar to that of the UC Davis Dengue Relief Foundation and World Mosquito Program [16] [29].

**Educational Outreach & Distribution:** Communicating with Public & Affected Areas With the general public, information regarding awareness and basic education of Dengue fever shall be distributed to make it more understandable to more diverse groups. Recent literature has found that the most effective educational approach was through group education sessions as it allows individuals regardless of background to receive the same education of the disease. Group education sessions have been effective at adding to people's health beliefs and potentially making more individuals open to discussing the disease as an unconventional therapy and way to share what reliable treatments are available publicly to those who live in affected areas [40].

It may also be assured that awareness of Dengue fever can be known ubiquitously by implementing an annual celebration of World Dengue Day by individuals from anywhere and adding it to societal tradition. In another instance, to commemorate Dengue fever as a global disease, officials have also declared World Dengue Day as a day to spread awareness of the disease every year on May 16, according to the International Society for Neglected Tropical Diseases and Asian Dengue Voice and Action Group [27]. Celebrating this day requires political institutions to accept this national



day in their country/region and having public health officials convince public groups to learn about Dengue fever and be aware of its properties. In doing so, this day can be encouraged to be celebrated by individuals across the world to provide time for remembering and learning what this vector-borne disease is.

### Communicating Scientific Concepts with Diverse Populations

With educating Dengue fever also comes educating complex scientific concepts such as the biology of the vector and pathogen. To successfully communicate these topics to people of varying backgrounds/knowledge, the proposed control and prevention plan also aims to have educational institutions involved by requesting local schools to incorporate disease knowledge of Dengue fever into their curriculum. A study on improving knowledge, attitude, and practice on Dengue in Colombian rural primary schools proved very effective as the disease was taught to students, parents, and teachers [25]. Some other specific barriers such as language/dialect and cultural practices can be overcome by hiring professional interpreters in health and conducting

research on what current treatments are available to a local region and how effective they are at treating Dengue fever while also adding to their health beliefs some outside practices such as a newly introduced vaccine and/or Western medicine practices.

### **Conclusion**

After meticulously addressing the components of the proposed control and prevention plan under the WHO, the main purpose of this plan is assured to expect long-lasting

effects at improving reduced infection and mortality in the Northern California region and global exterior regions. Consequently, vulnerable global population regions have been identified in warmer, humid regions along with areas affected by income and healthcare disparity. While limitations may exist, further research is mandatory on the efficacy of the suggested Dengue rapid diagnostic test and *Wolbachia* bacteria as some of these measures are novel and recently approved by institutions such as the CDC and California Department of Public Health [20]. In a concluding statement, following the steps of this proposal once approved by the WHO shall shape the future of reducing Dengue fever to potentially lead to its extermination from ever infecting humanity again.

## **References**

1. “*Aedes Aegypti* (Yellow Fever Mosquitoes).”  
*Biogents USA*, 4 Nov. 2022, [us.biogents.com/aedes-aegypti-yellow-fever-mosquitoes/](https://us.biogents.com/aedes-aegypti-yellow-fever-mosquitoes/).
2. “Average Temperature by Country, Trading Economics.” *Average Temperature by Country*, [tradingeconomics.com/country-list/temperature](https://tradingeconomics.com/country-list/temperature).
3. Bäck, Anne Tuiskunen, and Ake Lundkvist. “Dengue viruses - an overview.” *Infection ecology & epidemiology* vol. 3 10.3402/iee.v3i0.19839. 30 Aug. 2013, doi:10.3402/iee.v3i0.19839
4. Bifani, Amanda Makha, et al. “Intra-Host Diversity of Dengue Virus in Mosquito Vectors.” *Frontiers in Cellular and Infection Microbiology*, vol. 12, 2022, doi.org/10.3389/fcimb.2022.888804.
5. Carvalho, F D, and L A Moreira. “Why is *Aedes aegypti* Linnaeus so Successful as a Species?.” *Neotropical entomology* vol. 46,3 (2017): 243-255. doi:10.1007/s13744-017-0520-4

6. Chen, Yu-Pei et al. "Effects of Chinese and Western Medicine on Patients with Dengue Fever." *The American journal of Chinese medicine* vol. 48,2 (2020): 329-340.  
doi:10.1142/S0192415X20500160
7. *Dengue*, California Department of Public Health.cdpH.ca.gov/  
Programs/CID/DCDC/Pages/ Dengue.aspx.
8. "Dengue and Severe Dengue." *World Health Organization*, World Health Organization, who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue.
9. "Dengue Fever." *Mayo Clinic*, Mayo Foundation for Medical Education and Research, 5 Oct. 2022, mayoclinic.org/diseases-conditions/dengue-fever/diagnosis-treatment/drc-20353084#:~:text=No%20specific%20treatment%20for%20dengue,Decreased%20urination.
10. "Dengue in the US States and Territories." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 19 Aug. 2022,

cdc.gov/dengue/areaswithrisk/in-the-us.html#:~:text=Nearly%20all%20dengue%20cases%20reported,and%20limited%20to%20small%20areas. 11. “Dengue Worldwide Overview.” *European Centre for Disease Prevention and Control*, 30 Jan. 2023, [ecdc.europa.eu/en/dengue-monthly#:~:text=Situation%20update%2C%2027%20January%202023&text=The%20five%20countries%20reporting%20most%20new%20deaths%20are%20Indonesia%2\(229,have%20been%20reported%20in%20France](https://ecdc.europa.eu/en/dengue-monthly#:~:text=Situation%20update%2C%2027%20January%202023&text=The%20five%20countries%20reporting%20most%20new%20deaths%20are%20Indonesia%2(229,have%20been%20reported%20in%20France).

12. “Diagnosis.” *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 13 June 2019, [cdc.gov/dengue/healthcare-providers/diagnosis.html#:~:text=Nucleic%20acid%20amplification%20tests%20\(NAATs,or%20less%20after%20symptom%20onset](https://cdc.gov/dengue/healthcare-providers/diagnosis.html#:~:text=Nucleic%20acid%20amplification%20tests%20(NAATs,or%20less%20after%20symptom%20onset).
13. Echegaray, Fernando et al. “Adapting Rapid Diagnostic Tests to Detect Historical Dengue Virus Infections.” *Frontiers in immunology* vol. 12 703887. 23 Jul. 2021, doi:10.3389/fimmu.2021.703887
14. Edenborough, Kathryn M et al. “Using *Wolbachia* to Eliminate Dengue: Will the Virus Fight Back?.” *Journal of virology* vol. 95,13 (2021): e0220320. doi:10.1128/JVI.02203-20
15. Eliminate Dengue - Our Challenge.” *World Mosquito Program*, [eliminatedengue.com/program/](https://eliminatedengue.com/program/).

16. Gupta, Nivedita et al. "Dengue in India." *The Indian journal of medical research* vol. 136,31(2012): 373-90
17. Gwee, Sylvia Xiao Wei et al. "Animals as potential reservoirs for dengue transmission: A systematic review." *One health (Amsterdam, Netherlands)* vol. 12 100216. 20 Jan. 2021, doi:10.1016/j.onehlt.2021.100216
18. Lahondère, Chloé et al. "The olfactory basis of orchid pollination by mosquitoes." *Proceedings of the National Academy of Sciences of the United States of America* vol. 117,1 (2020): 708-716. doi:10.1073/pnas.1910589117
19. Malavige, Gathsaurie Neelika et al. "Efficacy of rupatadine in reducing the incidence of dengue haemorrhagic fever in patients with acute dengue: A randomised, double blind, placebo-controlled trial." *PLoS neglected tropical diseases* vol. 16,6 e0010123. 1 Jun. 2022, doi:10.1371/journal.pntd.0010123
20. Mallapaty, Smriti. "Dengue vaccine poised for roll-out but safety concerns linger." *Nature* vol. 611,7936 (2022):434435doi:10.1038/d41586-022-03546-2

21. Marano, Marli. "The Increasing Burden of Dengue Fever in a Changing Climate." *The Rockefeller Foundation*, 14 Nov. 2022, [rockefellerfoundation.org/blog/the-increasing-burden-of-dengue-fever-in-a-changing-climate/#:~:text=Warmer%20temperatures%20enhance%20dengue%20virus,higher%20elevations%20and%20latitudes.](https://www.rockefellerfoundation.org/blog/the-increasing-burden-of-dengue-fever-in-a-changing-climate/#:~:text=Warmer%20temperatures%20enhance%20dengue%20virus,higher%20elevations%20and%20latitudes.)
22. Poonpanichakul, Tiraput et al. "Innate Lymphoid Cells Activation and Transcriptomic Changes in Response to Human Dengue Infection." *Frontiers in immunology* vol. 12 599805. 17 May. 2021, doi:10.3389/fimmu.2021.59980.
23. Prompetchara, Eakachai et al. "Dengue vaccine: Global development update." *Asian Pacific journal of allergy and immunology* vol. 38,3 (2020): 178-185. doi:10.12932/AP-100518-0309
24. Rajapakse, Senaka. "Dengue shock." *Journal of emergencies, trauma, and shock* vol. 4,1 (2011): 120-7. doi:10.4103/0974-2700.7683

25. Sarmiento-Senior, Diana et al. "Improving knowledge, attitudes, and practices on dengue and diarrhea in rural primary school students, their parents, and teachers in Colombia: A cluster-randomized controlled trial." *PLoS neglected tropical diseases* vol. 16,12 e0010985. 27 Dec. 2022, doi:10.1371/journal.pntd.0010985
26. Seah, Annabel et al. "The effects of maximum ambient temperature and heatwaves on dengue infections in the tropical city-state of Singapore - A time series analysis." *The Science of the total environment* vol. 775 (2021): 145117. doi:10.1016/j.scitotenv.2021.145117
27. Srisawat, Nattachai et al. "World Dengue Day: A call for action." *PLoS neglected tropical diseases* vol. 16,8 e0010586. 4 Aug. 2022, doi:10.1371/journal.pntd.0010586
28. Tran, Bao-Linh et al. "Estimating the Threshold Effects of Climate on Dengue: A Case Study of Taiwan." *International journal of environmental research and public health* vol. 17,4 1392. 21 Feb. 2020, doi:10.3390/ijerph17041392



29. UC Davis Health, Department of Anesthesiology and Pain Medicine.  
“Dengue Surveillance System.” *Dengue Relief Foundation*, health.  
ucdavis.edu/pain/calendar/cal\_dengue.html. 30. Wong, Li Ping,  
and Sazaly AbuBakar. “Health beliefs and practices related to  
dengue fever: a focus group study.” *PLoS neglected tropical diseases*  
vol. 7,7 e2310. 11 Jul. 2013, doi:10.1371/journal.p

## NAVIGATING THE IMPLEMENTATION CHALLENGES OF SUPERVISED CONSUMPTION SITES

DYLAN ROGERS



---

*WRITER'S COMMENT: During my first year at UC Davis, my passion for healthcare led me to join a student-run clinic, where I quickly became captivated by the philosophy of Harm Reduction. The more I learned on this subject, the more I wanted to know and, before I knew it, I was fixated. Therefore, when Dr. Brenda Rinard introduced our main writing project for the quarter – a literature review on a sociological topic of our choosing – I knew exactly what I would focus on. Throughout my involvement with the clinic, I was always baffled by the controversy that surrounds Supervised Consumption Sites. Everything I had learned and seen as a provider led me to conclude that these sites are highly effective in reducing drug-related health issues, yet they struggle to gain support. Thus, I used this paper as an opportunity to explore the challenges associated with implementing these sites, considering barriers before, during, and after the implementation process. I hope the research presented here inspires a deeper compassion for these services and the individuals who rely on them.*

*INSTRUCTOR'S COMMENT: In my Writing in Sociology class, students explore a sociological topic of their choosing. During the research process, students first learn how to find relevant and credible sources. They then evaluate, summarize, and synthesize those sources in order to write an evidence-based paper. Dylan chose a topic he had work experience with, supervised consumption sites, in order to understand the controversy surrounding them, and the best practices for their operation. Dylan's resulting paper shows that his passion and dedication*

*to this topic created a paper full of rigorous critical analysis, empathy, and compassion.*

*-Brenda Rinard, University Writing Program*

Despite their demonstrated success in improving public health and providing crucial support to individuals who use drugs, Supervised Consumption Sites remain a topic of controversy. As a facility that is built on providing people with a safe place and sterile equipment to inject drugs, these efforts have been judged as enabling or promoting drug use. However, research on this subject reveals that Supervised Consumption Sites (SCSs) reduce harm in their local communities, they don't cause it (Watson et al. 2012; Jozaghi et al. 2014; Jozaghi 2015; Irwin et al. 2017; Kennedy et al. 2017; Caulkins et al. 2019; Baker and McCann 2020; Manson-Singer and Allin 2020; Yang and Beletsky 2020; Livingston 2021; Taylor et al. 2021; Urbanik et al. 2022; Ivsins et al. 2023; Perlmutter et al. 2023). To better understand this, it is important to explore the philosophy from which the SCS design was founded – Harm Reduction. The core intention of the Harm Reduction (HR) approach is to reduce the negative consequences that are associated with risky behaviors through pragmatic and individualized strategies (Hawk et al. 2017). While the Harm Reduction ideology encompasses all forms of risky behavior, its services predominantly focus on enhancing safety in drug use. Services in this area include providing sterilizing and safeguarding equipment such as alcohol wipes to clean the skin, mouthpiece covers to reduce the risk of disease when sharing pipes, snorting cards to prevent using off of public surfaces, and cotton filters to draw injectable substances through. Given the global surge in opioid-related deaths, HR efforts have allocated a significant portion of their resources toward confronting the pressing issue of the Opioid Crisis. These efforts are grounded in the HR principle that recognizes advocating for abstinence as an

ineffective approach in addressing an individual's safety during drug use. While understanding that drug use is part of our world, and that it will continue to be as long as there are drugs to use, HR organizations promote syringe exchange programs for people who inject drugs (Watson et al. 2012). Syringe exchange programs seek to supply individuals with sterile needles for injection, while also reducing biohazardous waste by receiving used needles in return. However, while this service is efficient in reducing exposure to harmful bacteria and improper handling of biohazardous waste, it fails to address numerous other safety concerns. This is where Supervised Consumption Sites come in to fill those neglected gaps and give comprehensive attention to the safety of people who use drugs (PWUD).

### ***SCS Solutions And Services***

Since Switzerland implemented the first SCS in 1986, these facilities have expanded to over 100 locations in 11 countries worldwide with zero fatalities. In the United States where there are only two SCSs in operation, the toll of overdose deaths is equivalent to one life lost every five minutes (NHRC 2023). Beyond overdoses and casualties, the full range of health complications stemming from improper drug use methods has too many categories to be accurately measured. With this issue in mind, SCSs strive to provide comprehensive services to address and mitigate as many of these conditions as possible. For example, one of the most pressing concerns for PWUD is the challenge of accessing a consistent supply of sterile needles and syringes. All too often, this obstacle only leads people to resort to riskier substance injection methods, such as reusing needles. Needles are intended to be single-use instruments, and this becomes evident in how quickly the tips lose their point. After just a couple of uses, needles begin to curve and, in practice, this can result in them snagging as they are withdrawn from the body. In addition to wounding injection sites, used needles are likely to harbor harmful bacteria,

which is especially true if an individual is reusing someone else's instrument (Zabaleta-del-Olmo et al 2016). In order to reduce the risks associated with needle sharing or needle reuse, providing sterile equipment is the primary service offered at SCSs. However, when this provision is the only service available, there remains a significant concern over the conditions in which individuals are injecting. Adhering to one of the fundamental principles of Harm Reduction, which advises against using substances alone, SCSs also provide supervision in the case of misuse. These supervisors are trained and equipped to effectively reverse overdoses, which claim more than enough lives annually for countries all over the world to declare a state of opioid crisis (Ivsins et al. 2023).

### ***Stakeholder Perspectives***

For as long as the HR movement has been dedicated to advocating for the safety and well-being of PWUD, it has been met with a debilitating resistance from community members. This resistance has hindered the ability of HR efforts to establish an adequate number of SCSs to combat the ongoing Opioid Crisis. Compared with supportive views, the content mentioned in opposing views of stakeholders lack substantial support in research. Nonetheless, their opinions still matter when it comes to the success of SCS policy proposals. When examining the perspectives of key stakeholders through research, the focus is placed on those who have a vested interest in, or would be directly impacted by, the establishment and operation of SCSs, such as emergency service providers, law enforcement, and the people who would be using SCS services. That said, the perspectives of PWUD will be given more emphasis during a later section of this paper that reviews SCS accessibility and efficacy factors in established facilities. The perspectives that will be considered here are preliminary, in that they pertain to the concept of implementing SCSs in areas where they currently do not exist. This section of examination is meant to introduce and understand the attitudes prevalent in

communities before reviewing the experiences related to successful and unsuccessful SCS policy proposals.

### ***Supportive Views***

Regardless of the inherent challenges in implementing SCSs, there is no lack of supportive attitudes among key stakeholders. For example, Emergency service providers (ESPs) bear the responsibility of treating drug use mishaps and overdoses where SCSs are absent. Therefore, when asked, the majority of ESPs would welcome a SCS in their community as it would lower their call volume for drug related issues. The service members recorded in this research include police officers, firefighters, paramedics, and social workers. As a result, these perspectives originate from diverse response efforts to drug related emergencies, such as law enforcement and de-escalation, medical treatment, and the provision of necessary resources. In addition to supporting SCSs due to the potential impact on call volume, ESPs are also reported as believing in the effectiveness of SCS services in reducing drug-use mishaps and overdoses (Perlmutter et al. 2023). Though, it should be noted that ESP perspectives have received much less attention in research compared to average community members. Therefore, further data is needed to determine the consistency of these sentiments on a broader scale.

Regarding the perspectives of average community members, those who do not serve PWUD and would not personally utilize SCS services, numerous qualitative studies have been conducted to explore their attitudes on the idea of SCSs being established within their communities. One common theme that has emerged during the process of researching these perspectives is the recognition that the purpose of SCSs is not intuitive and therefore requires some level of education to form an opinion (Baker and McCann 2020; Bardwell et al. 2020; Yang and Beletsky 2020; Taylor et al. 2021). Hence, many researchers choose to explore the attitudes of community members in regions with high prevalence of

opioid use, as they are more likely to have first hand exposure to the severity of the issues that SCSs aim to mitigate. While this approach may introduce a certain degree of bias, whether positive or negative, among the subjects, it also allows researchers to avoid the challenge of educating participants without unintentionally imposing their own leanings. It should be no surprise, then, that urban communities generally exhibit more accepting viewpoints compared to rural communities. Additionally, urban communities tend to have a broader awareness of the conditions surrounding the Opioid Crisis. Although they support the establishment of SCSs, they do not believe that implementing this new facility should take priority over expanding existing methods, such as rehabilitation treatment and syringe exchange programs. In other words, while community support for SCSs is evident, it is the uncertainties surrounding the logistics and implementation that hinder the majority from wanting to move forward. Based on these findings, researchers propose that the path towards communities embracing SCS implementation should begin with expanding less controversial HR services, while also promoting open conversations about the potential of taking this bigger step (Taylor et al. 2021).

### ***Unsupportive Views***

Despite the highly controversial nature of SCSs, the primary obstacle to their implementation lies in the uncertainty surrounding the community's ability to effectively operate these facilities, rather than the arguments put forth by unsupportive stakeholders. This is likely due to the understanding that both supportive and uncertain perspectives can be substantiated with research, while the unsupportive perspectives are largely refuted and dismissed as personal opinions. For instance, police officers express significant concerns about the implementations of SCSs, but recent research indicates that these concerns primarily revolve around the training provided to the staff. In particular, they question whether the staff will be adequately trained in de-escalation techniques, or if the police

will still be called to respond to incidents of drug-induced distress (Perlmutter et al. 2023). Logistics for successful SCS operation will be discussed more in the Efficacy and Accessibility section of this paper, but it is important to acknowledge here the validity of the concerns raised by police officers. These concerns directly influence their involvement at these facilities and, therefore, hold significant weight in their decision to support SCSs in their jurisdiction. Meanwhile, direct arguments against the implementation of SCSs stem from a lack of education on the nature of frequent drug use, the principles of Harm Reduction, and/or the advantages that these services would provide to the community as a whole.

In-depth interviews conducted with community members from counties with acute opioid usage revealed that there was a “not in my backyard” mentality regarding the implementation of SCSs, despite an overall acceptance of the concept. This attitude is rooted in the fear of increased crime and reduced property values in the neighborhoods surrounding these sites. However, these sentiments are more commonly observed among suburban community members rather than urban ones (Taylor et al. 2021). Furthermore, numerous peer-reviewed studies have extensively examined the prevalence of crime in areas before and after SCSs had been established there. Through varying methods of measuring and defining crime, the findings of these studies consistently indicate that there is no evidence to suggest that SCSs have any significant impact on the crime rate in their respective neighborhood (Kennedy et al. 2017; Caulkins et al. 2019; Livingston 2021).

Among stakeholders who hold completely unsupportive views, one of the most prevalent arguments is against the allocation of government funds for the establishment and operation of SCSs. These stakeholders, ranging from community members to government officials, understand that SCSs provide free services, which leads them to the conclusion that funding these facilities would result in a significant financial loss. However, these arguments fail to acknowledge the significant cost savings that can be achieved from implementing these services. In cost-benefit analyses of SCSs,



data from Canadian sites was examined and adapted to align with the economic context and healthcare trends of the United States. These studies assessed the costs associated with establishing and operating the facilities, and compared them with public health data from Canada before and after these services became available. This research specifically focused on public health records related to HIV and HCV infections, skin and soft tissue infections, overdose deaths, and medical assisted treatments for drug use disorder in cities with SCSs. The findings of these studies indicate that the reduction in health and medical costs resulting from the availability of these services has greatly outweighed the financial investments they require (Jozaghi et al. 2014; Jozaghi 2015; Irwin et al. 2017). When translated to match the economical context of the United States, SCSs are estimated to save their respective cities over twice as much money as they would cost them (Irwin et al. 2017). This suggests not only that cities would financially benefit from having SCSs, but that their services are actually effective in mitigating drug-related health concerns. Nonetheless, stakeholder attitudes are not the sole determining factor when it comes to the implementation of SCSs.

### ***Policymaking***

Assessing stakeholder attitudes represents the earliest phase in the process of implementing SCSs. As this next section will discuss, the success of SCS policy proposals heavily relies on the support of certain stakeholder groups. However, despite having such support, the overwhelming majority of SCS policy proposals worldwide have been unsuccessful. Consequently, research on successful factors for SCS policy proposals primarily consists of qualitative comparative analyses between the limited number of successful attempts and the numerous unsuccessful ones. Nevertheless, diverse research designs have revealed consistent patterns among settings that effectively adopted SCSs into their policy. Similarly, these studies have identified contextual factors that are common

between proposals that failed to achieve this outcome.

### ***Successful Policy Proposals***

A successful SCS policy proposal is characterized by the formal approval of these services by the local government. The policy itself encompasses evidence, objectives, challenges, and the support already garnered from stakeholders. Most of the evidence used in these policy drafts largely overlaps with the findings already mentioned in this paper. This includes the effectiveness of SCSs in reducing overdoses, unsafe injection methods, and disease transmission. Furthermore, the cost-effectiveness of SCSs as well as unaffected crime rates are key points emphasized in these proposals (Hayle 2018; Yang and Beletsky 2020). However, what set the evidence sections of successful proposals apart from unsuccessful ones was how they were framed. Drafts that positioned the objective of SCSs as a public health service, supported by evidence highlighting their effectiveness in curbing the transmission of HIV and reducing overdose fatalities, had a higher likelihood of gaining approval compared to drafts that presented SCSs solely as a service for people who use drugs. Successful proposals also frame the individuals using these sites as recipients of healthcare services and advocate for their criminal immunity when addressing the legal challenges associated with SCSs (Hayle 2018; Manson-Singer and Allin 2020; Yang and Beletsky 2020; Bardwell et al. 2020). However, comparative analyses consistently demonstrate that without the support of all three key stakeholder groups - the public, elected officials, and law enforcement - the policy proposal for SCSs is likely to be dismissed or rejected (Hayle 2018).

### ***Unsuccessful Policy Proposals***

Several studies have focused on Canadian provinces, examining the disparity in SCS policy outcomes throughout the history of the nation. In particular, research in Toronto has

attributed their history of rejected proposals to positioning SCSs as a criminal justice service. This approach led to a lack of support from law enforcement, as it would have placed additional responsibilities on the police (Hayle 2018; Manson-Singer and Allin 2020; Perlmutter et al. 2023). However, when Toronto shifted its perspective and framed SCSs as a public health service, the city was able to garner sufficient support to secure policy approval (Hayle 2018; Manson-Singer and Allin 2020). It is important to acknowledge that while these studies analyze areas within the same nation, the patterns observed between successful and unsuccessful SCS proposals may not be solely attributed to these factors. Other contextual elements, such as varying needs and mentalities across different regions, could contribute to the disparity in outcomes. Similarly, the approval of SCSs in Toronto after many failed attempts could be due to a growing acceptance of the concept or an increasing recognition of the need for such services. Therefore, conducting additional quantitative studies on these contextual factors would enhance the understanding of the requirements for SCS policy approval on a more general scale. That said, this area of research is rich in case studies, and the comprehensive local findings share numerous consistencies with one another. For instance, Australia has been recognized for its extensive history of unsuccessful policy proposals nationwide. However, these failures have ultimately contributed to a successful policy proposal by implementing similar adjustments to those observed in Canadian provinces. These adjustments include the use of destigmatized language to portray PWUD as individuals in need of care. Additionally, as discussed in the Stakeholder Perspectives section of this paper, Australian regions have gradually expanded less controversial HR services between policy proposals, which has led to increased support for the movement over time (Baker and McCann 2020; Taylor et al. 2021). Although policy approval is crucial for the implementation of SCS, it does not guarantee the construction or effective operation of these facilities.

### ***Efficacy and Accessibility***

Despite meeting the necessary requirements for policy approval, SCSs still face the risk of closure shortly after their implementation. Considering the prerequisites for their construction, the threat of closure is likely not due to a lack of necessity or support from their communities. Rather, studies attribute this issue to environmental factors or operational shortcomings of the facilities themselves (Bardwell et al. 2020; Urbanik et al. 2022; Ivsins et al. 2023). Through extensive research focusing both on the perspectives of PWUD and on identifying consistent patterns among idle facilities, key factors were identified as either barriers or facilitators to the efficacy and accessibility of these sites. These factors include the presence of law enforcement, the building design, the hours of operation, and the availability of additional resources.

### ***Barriers***

After noting all the efforts that are put into establishing SCSs, it is unfortunate to observe that many of them struggle to effectively serve their patient population. However, extensive research in this area has pinpointed specific deterrents for PWUD. Direct conversations with individuals who have utilized SCS services consistently highlight heavy police presence as one of the most commonly reported complaints. Near sites with excessive police surveillance, the fear of police intervention acts as a significant disincentive for individuals who would otherwise seek out the services of these facilities on a regular basis (Bardwell et al. 2020; Urbanik et al. 2022; Ivsins et al. 2023). While this conclusion aligns with the findings of most studies in this field, additional research on the quality of police presence near SCSs has revealed that when officers demonstrate an understanding of drug use and maintain a friendly attitude towards passersby, their presence is not perceived as a barrier to the accessibility of these facilities (Urbanik et al. 2022). Given this additional context, further examination of

the quality of police presence and their interactions with PWUD near SCSs could lead to a more comprehensive understanding of the influence that police have on the accessibility of these services.

Structural factors are another source of significant SCS accessibility barriers for PWUD. As for barriers relating to facility design, SCSs with main street entrances have been found to raise privacy concerns among visitors, as the visibility from the street can cause anxiety around being seen and judged while seeking care. Likewise, common use injection rooms are a design factor that lead individuals to report that their personal space is being violated. In addition to design factors, functional aspects of the facility also play a role in discouraging its use. Sites with strict regulations, such as mandatory identification requirements or extensive documentation processes, contribute to the perpetuation of stigmatized beliefs that PWUD are untrustworthy. Short operating hours create an inherent barrier to SCS accessibility and efficacy by limiting the number of individuals who can access their services. One significant consequence of this, as reported by visitors, is overcrowding, which leads to long wait times. Ultimately, this situation results in people either walking out or being turned away when the facility closes. This is incredibly ineffective because it does not prevent people from practicing unsafe consumption methods: “‘If it’s later in the evening and the health centre is closed, I’ll just go in the alley’ (Participant 16, cis woman, late 20s),” (Bardwell et al. 2020).

### ***Facilitators***

While facilities with a heavy police presence are often seen as less accessible to PWUD, those without police presence are considered safe spaces where individuals can engage in harm reduction practices without feeling stigmatized or identified as a criminal for doing so (Ivsins et al. 2023). This is easier to achieve with a better understanding as to why police feel entitled to surveil SCSs in the first place. Most research on police presence at SCSs primarily focuses on their unsupportive demeanor, often

overlooking the underlying reasons for their presence. However, preliminary research conducted in regions without SCSs suggest that police officers commonly expressed concerns about the staff's training at potential sites. Although they generally support the concept of SCSs, a portion of this support was contingent upon the facility staff being equipped with proper de-escalation training to handle drug-related conflicts so the police would not be called to intervene (Perlmutter et al. 2023). Nonetheless, based on visitor reports, the absence of police presence is considered a facilitator for SCS accessibility. Even in cases where police are understanding of drug use and supportive of SCS services, providing de-escalation training to facility staff might also contribute to improved accessibility.

In addition to facilitating access to SCS services, researchers have identified factors that encourage their utilization. Studies have shown that the unique values and features of each SCS play a significant role in the benefits people derive from visiting them. For instance, some sites provide safe spaces for people to sleep or relax, which is highly appealing to individuals experiencing homelessness who face the constant risk of assault while sleeping on the streets. There are also SCSs designed to resemble cafes, which have received positive reviews for reducing feelings of shame or anxiety around being labeled as a drug user when seeking services (Ivsins et al. 2023). Another example of varying SCS values is seen in those that specifically cater to vulnerable groups within the wider population of PWUD, such as women. Women-only SCSs have been regarded as safe havens for women, offering an escape and a place to connect with others who share similar circumstances. This is particularly important because women who use drugs are highly susceptible to being victims of violence (Boyd et al. 2020).

## *Conclusion*

Ultimately, this research highlights the significance of embracing the power of education. By acknowledging the historical challenges and opposing viewpoints surrounding the implementation of Supervised Consumption Sites, it becomes evident that their services are controversial. However, with a fundamental education on the research that has been conducted on the effectiveness of SCS services, their ability to incite positive change can only be denied if the lives of PWUD are not regarded as valuable. Therefore, I encourage people from all walks of life - students, police officers, government officials, healthcare providers, voters, etc. - to approach controversial topics, such as Harm Reduction services, with compassion and curiosity. It is by embracing these two qualities that we can cultivate a comprehensive understanding and enact the necessary services to combat overlooked humanitarian crises like the Opioid Epidemic.

## **Works Cited**

- Baker, T. and McCann, E. 2020. "Beyond failure: the generative effects of unsuccessful proposals for Supervised Drug Consumption Sites (SCS) in Melbourne, Australia." *Urban Geography* 41(9): 1179–97. <https://doi.org/10.1080/02723638.2018.1500254>
- Bardwell, G., Strike, C., Mitra, S., Scheim, A., Barnaby, L., Altenberg, J., and Kerr, T. (2020). "‘That’s a double-edged sword’: Exploring the integration of supervised consumption services within community health centres in Toronto, Canada." *Health and Place*, 61: 102245–102248. <https://doi.org/10.1016/j.healthplace.2019.102245>
- Boyd, J., Lavalley, J., Czechaczek, S., Mayer, S., Kerr, T., Maher, L., & McNeil, R. 2020. "‘Bed Bugs and Beyond’: An ethnographic analysis of North America’s first women-only supervised drug consumption site." *The International Journal of Drug Policy*, 78: 102733–102733. <https://doi.org/10.1016/j.drugpo.2020.102733>
- Caulkins, J.P., Pardo, B., & Kilmer, B. 2019. "Supervised consumption sites: a nuanced assessment of the causal evidence." *Addiction*, 114(12): 2109–2115. <https://doi.org/10.1111/add.14747>
- Irwin, A., Jozaghi, E., Bluthenthal, R. N., and Kral, A. H. 2017. "A Cost-Benefit Analysis of a Potential Supervised Injection Facility in San Francisco, California, USA". *Journal of Drug Issues*, 47(2): 164–184. <https://doi.org/10.1177/0022042616679829>



- Ivsins, A., Warnock, A., Small, W., Strike, C., Kerr, T., and Bardwell, G. 2023. "A scoping review of qualitative research on barriers and facilitators to the use of supervised consumption services." *The International Journal of Drug Policy*, 111: 103910–103910. <https://doi.org/10.1016/j.drugpo.2022.103910>
- Kennedy, M.C., Karamouzian, M., & Kerr, T. 2017. "Public Health and Public Order Outcomes Associated with Supervised Drug Consumption Facilities: a Systematic Review." *Current HIV/AIDS Reports*, 14(5): 161–183. <https://doi.org/10.1007/s11904-017-0363-y>
- Livingston, J. 2021. "Supervised consumption sites and crime: scrutinizing the methodological weaknesses and aberrant results of a government report in Alberta, Canada." *Harm Reduction Journal*, 18(1): 4–4. <https://doi.org/10.1186/s12954-020-00456-2>
- National Harm Reduction Coalition. 2020. "Getting ready: preparing yourself and your equipment" Getting Off Right Training Guide. Retrieved May 28, 2023 <https://harmreduction.org/>
- Hawk, M., Coulter, R. W. S., Egan, J. E., Fisk, S., Reuel Friedman, M., Tula, M., and Kinsky, S. 2017. "Harm reduction principles for healthcare settings." *Harm Reduction Journal*, 14(1): 70–70. <https://doi.org/10.1186/s12954-017-0196-4>
- Hayle, S. 2018. "A tale of two Canadian cities: Comparing supervised consumption site (SCS) policy making in Toronto and Vancouver." *Drugs : Education, Prevention and Policy* 25(5): 397–407. <https://doi.org/10.1080/09687637.2017.1292215>

- Jozaghi, E., Reid, A. A., Andresen, M. A., & Juneau, A. 2014. "A cost-benefit/cost-effectiveness analysis of proposed supervised injection facilities in Ottawa, Canada." *Substance Abuse Treatment, Prevention, and Policy*, 9(1). <https://doi.org/10.1186/1747-597X-9-31>
- Jozaghi, E. 2015. "Exploring the role of an unsanctioned, supervised peer driven injection facility in reducing HIV and hepatitis C infections in people that require assistance during injection." *Health & Justice*, 3(1). <https://doi.org/10.1186/s40352-015-0028-0>
- Manson-Singer, C., and Allin, S. 2020. "Understanding the Policy Context and Conditions Necessary for the Establishment of Supervised Consumption Sites in Canada: Comparative Analysis of Alberta and Manitoba." *Health Reform Observer*, 8(2). <https://doi.org/10.13162/hro-ors.v8i2.4114>
- Perlmutter, D., Wettemann, C., Fockele, C. E., Frohe, T., Williams, W., Holland, N., Oliphant-Wells, T., Meischke, H., and van Draanen, J. 2023. "‘Another tool in the toolkit’—Perceptions, suggestions, and concerns of emergency service providers about the implementation of a supervised consumption site." *The International Journal of Drug Policy*, 115: 104005. <https://doi.org/10.1016/j.drugpo.2023.104005>
- Taylor, J. Ober, A. J., Kilmer, B., Caulkins, J. P., and Iguchi, M. Y. 2021. "Community perspectives on supervised consumption sites: Insights from four U.S. counties deeply affected by opioids." *Journal of Substance Abuse Treatment*, 131: 108397–108397. <https://doi.org/10.1016/j.jsat.2021.108397>

- Urbanik, M. M., Maier, K., and Greene, C. 2022. "A qualitative comparison of how people who use drugs' perceptions and experiences of policing affect supervised consumption services access in two cities." *The International Journal of Drug Policy*, 104: 103671–103671. <https://doi.org/10.1016/j.drugpo.2022.103671>
- Watson, T. M., Bayoumi, A., Kolla, G., Penn, R., Fischer, B., Luce, J., and Strike, C. 2012. "Police Perceptions of Supervised Consumption Sites (SCSs): A Qualitative Study." *Substance Use and Misuse*, 47(4): 364–374. <https://doi.org/10.3109/10826084.2011.645104>
- Yang, T.Y. and Beletsky, L. 2020. "United States vs Safehouse: The implications of the Philadelphia supervised consumption facility ruling for law and social stigma." *Preventive Medicine*, 135: 106070–106070. <https://doi.org/10.1016/j.ypmed.2020.106070>
- Zabaleta-del-Olmo, E., Vlachos, B., Jodar-Fernández, L., Urpí-Fernández, A.-M., Lumillo-Gutiérrez, I., Agudo-Ugena, J., Morros-Pedros, R., and Violán, C. 2016. "Safety of the reuse of needles for subcutaneous insulin injection: A systematic review and meta-analysis." *International Journal of Nursing Studies*, 60: 121–132. <https://doi.org/10.1016/j.ijnurstu.2016.04.010>

## PULMONARY EFFECTS OF SILVER NANOPARTICLE PREPARATIONS BY SIZE, SHAPE, AND CHEMICAL COMPOSITION

ANITA AKEF



---

*WRITER'S COMMENT: The Global Disease Biology major introduced me to the world of research, igniting my passion for exploring the research field. As I became more involved as a laboratory assistant and gained greater exposure to research, my interest surpassed the criteria set for the GDB practicum. Being a premed student, I am driven by my deep-rooted passion for medicine and improving human health. Participating in impactful research projects has been a fulfilling experience. My family's personal encounters with respiratory diseases have heightened my concern about the potential health risks associated with everyday products. The study on the effects of Silver nanoparticles on lung health has provided me with a valuable opportunity to investigate their impact on our well-being. Silver nanoparticles are commonly present in numerous products we use daily, and understanding their effects on lung health and disease development is crucial. I am grateful to Dr. Kent Pinkerton, my Principal Investigator, for making the Global Disease Biology major practicum project at the Center for Health and Environment a reality. His guidance and support have been invaluable throughout my academic and research journey.*

*INSTRUCTOR'S COMMENT: Anita Akef is a Global Disease Biology major who performed research in my laboratory at the Center for Health and the Environment. Anita's interest was to assist us to better understand the health implications of engineering nanomaterials composed of silver that could be potentially inhaled into the lungs due to their ease in becoming aerosolized and their small size. She developed a*

*special method to visualize these silver nanoparticles in individual cells and in lung tissues called autometallography.*

*-Kent Pinkerton, Center for Health and Environment*

### ***Abstract***

Engineered Silver nanoparticles (Ag NPs) can be found in hundreds of consumer products, medical applications, and medical supplies. Ag NPs are also used in multiple products as antibacterial protectants including paints, plastic wrap, and styrofoam containers. Approximately 50% of all products using engineered nanomaterials contain Ag NP. However, questions remain regarding the risks associated with Ag NP exposure. To better understand these nanomaterials, this study examined Ag NPs with varying sizes and chemical compositions. Three formulations of Ag NPs were tested: 20 nm (C20) and 110 nm (C110) citrate-stabilized Ag NPs, and 50 nm silver silicate (AgSiO<sub>2</sub>) NPs. Male Sprague Dawley rats were instilled intratracheally with Ag NPs (1.0 mg/kg body weight [BW]) using 20 nm, 110 nm, and AgSiO<sub>2</sub> (50 nm). Bronchoalveolar lavage fluid (BALF) and lung tissues were obtained 1-day post-exposure for analysis of BAL cells and histology. To visualize Ag NPs in BAL and lung tissues, autometallography was implemented. All three Ag NPs induced elevated numbers of polymorphonuclear cells (PMNs), eosinophils, and lymphocytes in the BALF 24 hours post-instillation. Autometallography helped to visualize the uptake of all three types of Ag NPs predominantly in alveolar macrophages of the BAL. Histology of lung tissues further confirmed the rapid uptake of Ag NPs in the airway epithelium, underlying submucosa, and interstitial spaces with the aid of staining by autometallography. No overt structural remodeling of cells or tissues of the lungs was noted. Some evidence based on lymphocyte and eosinophil response might indicate a greater

response to 110 nm Ag NPs and AgSiO<sub>2</sub> compared to 20 nm Ag NP at an equal mass concentration. These findings suggest all three Ag NP preparations produce a mild inflammatory response with rapid uptake predominately in alveolar macrophages, while also depositing on the airway epithelium, and entering the underlying interstitial tissues of the alveoli.

### ***Introduction***

Silver nanoparticles (AgNPs) are metallic silver particles manufactured through newly evolving engineering nanotechnology. These nanomaterials are revolutionary and show great promise in applications in medicine, industry, agriculture, a vast number of consumer products, and healthcare (Zhang et. al., 2016). Silver nanoparticles have unique physical and chemical properties which serve as a catalyst for chemical reactions, and provide antibacterial properties in medicine to make them one of the most commonly used nanomaterial metals (Sung et al., 2008). AgNPs have been considered essential in many household products such as textiles, utensils, cosmetics, food processing, and packaging. As a result, environmental exposure to AgNPs has increased significantly. Characteristics of AgNPs such as size, shape, solubility, etc. are important factors contributing to their efficacy, but may also play a potential role in evaluating the potential toxicity in plants, animals, and humans (Zhang et. al., 2016). The utilization of AgNPs in various fields has raised concern about the potential negative impacts they may have on health and the environment. The common dimensions for engineered AgNPs size range from 1 to 100 nm. Variations in the size of silver particles have been found to affect their functionality, particularly in a wider variety of fields including medicine. Smaller sizes of AgNPs have demonstrated enhanced antimicrobial activity, which is a desirable property in many medical applications and the packaging of agricultural products for preservation. However, reducing the size of AgNPs can result in an increase in the number of nanoparticles per unit of

mass, which may lead to enhanced toxicity (Ferdous & Nemmar, 2020). One of the major mechanisms of exposure to AgNPs in small dimensions is through direct skin contact and inhalation. The pulmonary route is one of the most common routes of exposure. The potential extent of effects could likely be influenced by the size, shape, and chemical composition of AgNPs. Excess release of AgNPs into the environment due to industrial and agricultural use may also result in pollution to increase environmental concentrations, as well as the potential extent and impact of silver deposition rates through biodistribution (Ferdous & Nemmar, 2020). Prolonged exposure to AgNPs specifically via the respiratory tract by inhalation as shown by various studies increases the possibility of Ag NP translocation through alveolar tissues into different organs and the systemic circulation of the body (Sung et al., 2008). Also, more importantly, it has been shown that particles smaller than 1µm are capable of deeper penetration in lung tissues (Ferdous & Nemmar, 2020).

This study will focus on the pulmonary effects of different sizes and chemical compositions of silver nanoparticles upon exposure by intratracheal instillation in rats to investigate the acute effects of AgNPs on lungs 24 hours post-exposure. Three different preparations of silver nanoparticles were used: 1% AgSiO<sub>2</sub> with an equivalent diameter of 50nm, 20nm AgNP, and 110nm AgNP to evaluate the impact of Ag nanoparticles on the respiratory system. Also, this research aims to investigate the degree of inflammation due to immune effector cells, as well as the degree of uptake of silver nanoparticles by inflammatory cells and tissues of the lung, based on size and chemical composition.

## ***Materials And Methods***

### **Silver Silicate nanoparticles (Physical Characterization)**

The Ag-SiO<sub>2</sub> NPs used in this study were synthesized, characterized, and supplied in powder form by the National Institute of Environmental Health Sciences Centers for Nanotechnology Health Implications Research Consortium. Ag-SiO<sub>2</sub> NPs were synthesized by flame spray pyrolysis as silver (~8nm) supported on silica (~7nm) (3.79% w/w) (Beltran-Huarac, Zhang, et al., 2018). The powdered Ag-SiO<sub>2</sub> NPs were  $10.64 \pm 7.10$  nm in diameter prior to suspension in endotoxin-free water at a concentration of 1 mg/ml for aerosolization. The primary particle size, primary particle size distribution, and size factor were characterized by imaging analysis with a transmission electron microscope (TEM). Crystallinity, density, and chemical composition were characterized by X-ray diffraction, pycnometer, and inductively coupled plasma mass spectrometry (ICP-MS) respectively (Beltran-Huarac, Zhang et al., 2018).

### **20 and 110 nm Silver Nanoparticles (Physical Characterization)**

Physicochemical characterization of stock Ag NPs. Two distinct Ag NP types were tested to include 20nm (C20) and 110nm (C110), both citrate-stabilized NPs. The two NP formulations were purchased from nanoComposix, Inc (San Diego, California), where each was synthesized as a custom-order, single batch from the BioPure line of materials, and supplied by the National Institute of Environmental Health Sciences Centers for Nanotechnology Health Implications Research (NCNHIR) consortium. Physicochemical particle characterization of Ag NPs received from nanoComposix was completed by the National Characterization Laboratory (Frederick, Maryland), and published in part (Wang et al., 2013). Briefly, transmission electron microscope (TEM) images of both NP sizes (20 and 110 nm) were taken to confirm



the primary particle size and morphology. Dynamic light scattering (DLS) and zeta potential measurements were also completed to characterize the hydrodynamic size and electrostatic potential of the nanomaterials in aqueous media. Because silver ions have been shown to cause adverse health effects (Wang et al., 2013), both elemental Ag and free Ag concentrations were monitored for a period of 8 months before use. Inductively coupled plasma mass spectrometry (ICP-MS) was used to determine the elemental composition of the particles and the endotoxin content of the NP stock suspensions was also measured using the Kinetic Turbidity and Gel-clot Limulus amoebocyte lysate (LAL) assays. Additional characterization (TEM and DLS) of Ag NPs was performed as described by (Anderson et al., 2014) to confirm particle size and dispersion prior to IT.

### ***Animals***

Male Sprague-Dawley (SD) rats (Harlan Laboratories, Inc, Hayward, CA) 12 weeks of age, were used for all experiments and maintained as previously described (Silva et al., 2013) in accordance with UC Davis Institutional Animal Care and Use Committee. Prior to exposure, animals were randomly assigned to treatment groups. Animal weights were recorded throughout the study to monitor overt signs of distress. Sentinel rats were maintained in the same room and tested to ensure experimental animals remained free of pathogens and/or parasites.

### ***Method of nanoparticle administration in rats***

The method that was used to administer exposure of rats to each silver nanoparticle preparation was by intratracheal installation (IT). This method is widely used in experimental studies for respiratory toxicity assessments in which the goal of the study is to monitor effects as a result of inhalation of the material. Using the IT

method for exposure, animals were sedated using isoflurane 3.0% using a sedation box they became anesthetized for 15 minutes. Each animal in the three different treatment groups received 1mg/mL in 250 $\mu$ L of the respective silver solution preparations using a standard bulb-tipped gavage needle which directly deposit the solution into the lungs through the trachea (Hasegawa-Baba, et. al, 2014). Animals were given 24 hours of time post-exposure to the treatment before proceeding with the necropsy procedure.

## **Necropsy**

1. The following steps were performed during each necropsy: The necropsy procedure occurs 24 hours post-exposure and begins by euthanizing the animal (rat) by injecting them with 0.2 ml Beuthanasia which has been diluted in a 1:6 ratio with double distilled water.
2. Then the animal weight is collected on the necropsy sheet. The animal is then placed on the absorbent sheet and secured with all the hands and feet and the tail of the animal to the paper using tape.
3. Using a pair of necropsy tweezers we ensure that the animal is adequately euthanized by pinching the paw. There should be no reflux upon pinching, otherwise, wait longer or more euthanasia will be administered by the lab technician.
4. A pair of tweezers are used to hold up the skin of the animal in the abdominal area and surgical dissecting scissors are used to make a midline incision from the rib cage to the top of the sternum of the animal.
5. The thoracic cavity is opened from the diaphragm to the top of the sternum ( This process should be done very carefully as it is easy to puncture the lung tissue).

6. Cardiac puncture is performed by using a syringe and drawing the blood from the apex of the heart. The blood collected from animals will be secured in the respective tubes for separating the plasma using a centrifuge.
7. The diaphragm is secured in place using a pair of hemostats.
8. Clearing the surrounding area of the trachea is done using a swab. Two tweezers are used to pass a suture around the trachea. A cannula is placed in the trachea by making a small incision using a razor blade on the anterior aspect of the trachea. The cannula is secured in place in the trachea with the suture.
9. The cannula is maintained in place in a horizontal position while connecting it to a syringe containing 7-8 mL of buffered sterile saline (PBS) for the lavage of the right lung lobes. This is accomplished by clamping the left mainstem bronchus, while instilling and recovering PBS into the right lung lobes three times prior to the final recovery of the PBS from the lungs into the syringe. This procedure is known as lung lavage and the fluid recovered is known as bronchoalveolar lavage fluid (BALF). As much BALF as possible is recovered in this final withdrawal of fluid from the right lung lobes. The syringe is removed from the cannula and the BALF is placed in a sterile test tube and placed on ice.
10. The collection of lung tissues is done by placing a suture around the right lung to separate the left and right lungs from each other. Tweezers are used to pass the suture beneath the right lung lobes to separate them from the left lung with the suture securely closing the right mainstem bronchus.
11. Once the right mainstem bronchus is closed, the right lung lobes can be removed and separated into the cranial, middle, caudal, and accessory lobes for freezing.

12. The left lung is removed with the trachea along the cannula detached from the entire body and processed for preservation.

### **Processing the left lung lobe for histological analysis**

Processing the left lung: once the left lung is removed with the trachea attached to it, the lung is fixed using a 4% paraformaldehyde solution at a hydrostatic pressure of 30 cm of fixative to preserve the tissue in a state of inflation. Following 24 hours of fixation, the left lung is cut into transverse slices and dehydrated using an ethanol/toluene gradient. The slices are then infused with paraffin wax. These steps of tissue dehydration and wax embedment are accomplished using an autotechnicon system. This system is routinely used to embed animal tissues in paraffin wax blocks, followed by the use of an embedding system. Once the tissue is embedded it is ready to be sectioned into 5µm slices which are placed on glass slides. The slides with the tissue are then used for staining with different staining techniques for analyzing different tissue compartments of the lung. A unique stain is done with autometallography to detect silver in the tissues. Hematoxylin and eosin (H&E) stains are used to fully visualize all tissue compartments of the lungs and to facilitate histological analysis of the level of inflammation in the airways and alveoli. Right lung tissue removed from the animal is preserved by flash freezing technique for future analysis. Different lobes of the right lung are frozen instantly by placement in Eppendorf cryotubes dropped into a styrofoam box filled with liquid nitrogen for instant freezing. Right lung tissues can be used for further analyzing each treatment group with techniques such as performing ELISA using extracted protein from the tissue or quantifying RNA using the RT-qPCR technique.

## **BALF**

Bronchoalveolar lavage fluid (BALF), the liquid recovered from animal lungs during the necropsy procedure, contains the immune response cells. We use the BALF recovered to prepare cytopsin slides. For making cytopsin slides we first centrifuge the BALF at 2000rpm for 15 minutes at 4°C. This results in a cell pellet, which is resuspended in PBS. 100 ul of resuspended cells are observed under the microscope to determine cell number and cell viability. Cell viability is determined using a Trypan Blue solution in the resuspended cell mix. If the cells are dead they will turn blue as a result of their permeable membrane. After counting an additional 100 ul of recovered BALF is placed on glass slides using a Shandon cytopsin system to create the cytopsin slides. The cytopsin slides can be used for observing the cell differentials of each animal in the study.

## **Staining techniques for cytopsin slides**

After the removal of cytopsin slides from the cytopsin system, the cytopsin slides were allowed to dry for approximately 10 minutes before beginning the staining process. Two methods of staining were performed on cytopsin slides for this study. Hematoxylin and Eosin (H&E) staining has multiple stages and is typically used to stain tissue sections. The deparaffinization step is done only for the tissue slides and not the cytopsin slides. However, our study included both procedures including this stain typically used only for tissue samples.

1. Dip the sample slide in the first Toluene/Xylene container and leave it for 5 minutes. Then remove and place the slide in the next Toluene/Xylene container and again leave it for 5 minutes. Repeat in the next container with the same chemical but for 2 minutes. The first step is deparaffinized the tissue on the slide by dehydrating the sample slide in Toluene/Xylene chemical.

2. Rehydration of the sample slide using three different concentrations of ethanol. 100% EtOH, 95% EtOH, and 70% EtOH are used respectively dipping the slides for 2 minutes in each solution.
3. The following steps for the staining process of the sample slide are the first stain the slide in filtered Harris Hematoxylin for 5-6 minutes (optimize), and dip in double distilled water (DDS) 2-3 dips. Soak the slide in the next DDS container for 1 minute. Then dip the slides in differentiating solution 2-3 times. Then dip in DDS 2-3 dips followed by soaking in another DDS container for 1 minute. Leave the slide in Blurring solution for 45 seconds then dip them in a DDS container 2-3 times and soak them for another 1 minute in individual containers of DDS. The last step for staining the slide sample is Eosin Y, leave the slides in the Eosin container for 2-3 minutes (optimize).
4. The following step is to dehydrate the sample, 3 different concentrations of ethanol are used from lowest to highest 70%EtOH,95%EtOH, and 100%EtOH for dehydrating the tissue consecutively for 2 minutes each time.
5. The last step is Toluene/Xylene soak which is done for two minutes in three different containers consecutively.
6. Upon completion of the staining process, the slides are coverslipped using clear-mount glue and coverslip under the fume hood to avoid any dust.

### **Diff-Quik Stain**

The second staining method used for cytopsin slides consists of staining with solution A (hematoxylin-like stain) followed by clearing the slide with PBS. The second step is staining with solution B (eosin-like stain) followed by rinsing of the slide with PBS. The Diff-Quik staining method is done manually by dipping repeatedly each cytopsin slide 15 times in solution A, followed by

rinsing in PBS, and then dipping the cytospin slide in solution B 15 times, again following by rinsing the slides in PBS. These cytospin slides are allowed dry and then coverslipped with clear-mount.

### **Authometallography Staining**

This special stain was performed on all cytospin slides as well as on all tissue slides. The autometallography staining technique allows for the detection of silver in cells forming both the immune response cells from the BALF and the lung tissues. For this technique, a special silver enhancing kit was used to perform the staining.

1. Deparaffinize the sample tissue using a xylene solution for 5 minutes each time in three different containers of xylene. ( cytospin slides skip the deparaffinization process and instead are soaked in DDS for 5 minutes)
2. Hydrate the tissue using three different ethanol solution concentrations 100% for 5 minutes, 95% for 5 minutes, and 70% for 5 minutes. Followed by soaking in a DDS container for another 5 minutes.
3. Mix equal volumes of initiator and enhance, and stain the tissues for 10-15 minutes depending on the type of tissue for this study 15 minutes were used. Using a plastic transfer bulb pipet solution mixture was transferred on the tissue by drops.
4. Counterstaining is done with 1% toluidine blue to make visualization easier for the tissue and the silver. Followed by coverslipping.

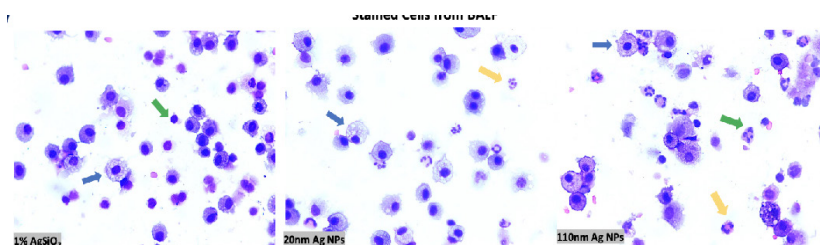
### **Cell differential counts**

1. Turn on the brightfield microscope and the computer
2. Place the slide under the microscope
3. adjust the stage on the microscope as well as adjust the

- light intensity and magnification. For this study, we used 40X magnification to observe clear cells.
4. Begin counting the cells from the top left moving forward. Enter the number of cells observed on each slide on the cell counter which has labels for each type of cell. Count cells until reaching 500 cells on each slide.
  5. Record the number of cells to be used in calculations.

## ***Results***

### **Stained Cells From BALF**



**Figure 1. Differential identification of inflammatory cells recovered from the lungs by bronchoalveolar lavage on cytospin slides stained with Diff-Quik.** Macrophages ( →) contain a single nucleus and are highly vacuolated. Eosinophils ( →) are multilobulated with pink cytoplasm. Lymphocytes ( →) have a single nucleus with scant cytoplasm.



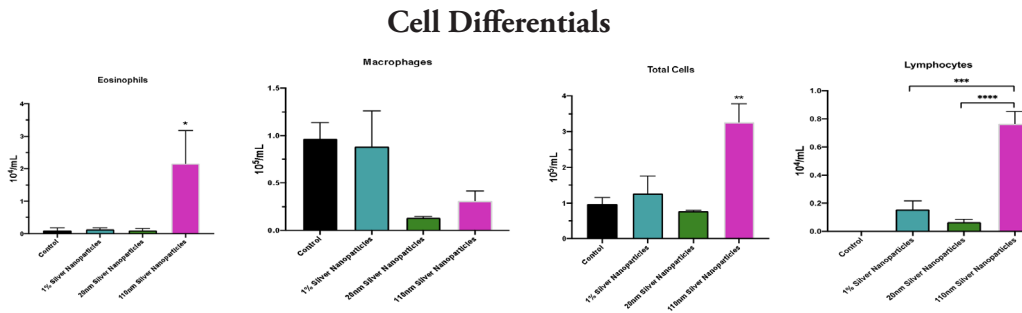


Figure 2. Statistical analysis of inflammatory cells in response to intratracheal instillation of the three silver nanoparticle preparations. The total cell number was relatively similar across all groups. The 1% AgSiO<sub>2</sub> Ag preparation showed a slightly higher number of macrophages compared to the 20nm and 110nm Ag NPs preparations. The number of eosinophils and lymphocytes were markedly higher in the 110nm Ag NPs preparation than in the 1% AgSiO<sub>2</sub> and 20nm Ag NPs preparations. \*  $p < 0.05$ , \*\*  $p < 0.005$ , \*\*\*  $p < 0.0005$ , \*\*\*\*  $p < 0.00005$

### Autometallography On Cytospin Slides

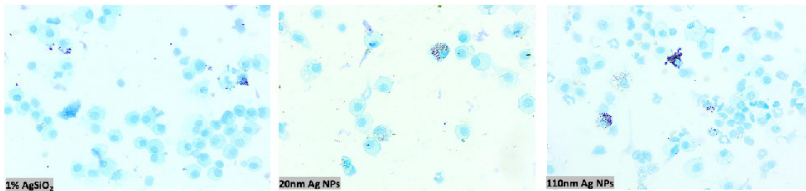
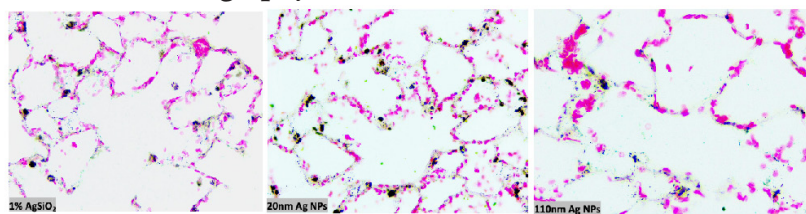


Figure 3. Silver nanoparticles visualized on cytopsin slides following staining with autometallography. The silver nanoparticles taken up by cells are noted as dark punctate pigmentation. Alveolar macrophages are the dominant cell type taking up silver nanoparticles.

### Autometallography on Tissue Sections



**Figure 5.** *Silver nanoparticles were found in the lungs of rats by staining with autometallography. Silver nanoparticles are found primarily in alveolar macrophages to varying degrees of intensity. All lung tissue section images were taken using a 40X objective lens on a brightfield microscope.*

### Discussion

The results of cell differentials and total cell counts from the bronchoalveolar lavage fluid of treatment groups indicated that there was an immune response in the lung due to an increased number of inflammatory cells that were present in the lung when it was recovered during necropsy. Figure 1 shows the different types of cells that were present in the cytospin slides that were made from the BALF. The types of inflammatory cells present in the lungs were macrophages, eosinophils, and lymphocytes. There were other inflammatory cells such as neutrophils present at lower concentrations compared to other types of cells. The statistical analysis from BALF cell differentials (figure 2) indicates an increase in the number of total cells in the lung. The increase of total cells was significantly higher in the treatment group 110 nm silver nanoparticle. Especially the number of lymphocytes and eosinophils present in the 110 nm AgNPs was significant compared to the other treatment groups. 1% AgSiO<sub>2</sub> compared to other treatment groups showed more elevation in the number of macrophages, but comparable to the sham control group. Figure 3 and Figure 4 both confirm the presence of AgNPs in the tissue and the bronchoalveolar lavage fluid cells. In auto metallography staining images in Figure 3 the uptake of silver is apparent in all

three preparations. However, macrophages in the 110nm treatment group show a greater amount of uptake of the silver depositions. In Figure 4 the AgNPs are found to be in the alveolar macrophages which were present in all of the different preparations of AgNPs.

### ***Conclusions***

This study focused on the level of impact of silver nanoparticles based on chemical composition, size, and shape on the lungs. The study evaluated the impact based on these factors over the course of 24 hours post-exposure on the animals. In all three preparations of Ag NPs treatment groups, we have seen demonstrations of significant cellular uptake of the silver into the cells. Predominantly the uptake of silver by macrophages indicates varying degrees of inflammation in the lungs. These macrophages are known to be alveolar macrophages and are the first types of immune response cells that get recruited into the lung for the immune response against an unknown pathogen or chemical that enters the airways ( González-Vega, et. al, 2022). Different amounts of inflammatory cells that were induced due to the different preparations of the silver indicated that the 110nm AgNPs caused a significant amount of inflammation compared to the other preparations. In the 1% silver silicate preparation the silver is coated with a layer of silicate which gets dissolved quickly in this chemical composition. Due to this property and with reference to Figure 2 and the elevation of macrophages in 1% silver silicate treatment could be due to the release of silver particles and induction of inflammatory cells at the same time we observe higher amounts of cells. This observation potentially indicates that the different preparations of AgNPs promote different inflammatory types of cells alongside varying levels of response in the lung ( González-Vega, et. al, 2022). In accordance with the results obtained from the BALF analysis, we concluded that the 110nm AgNPs resulted in a greater flux of total cells including eosinophils and lymphocytes in the lungs. The high influx of eosinophils and lymphocytes in the lung could be strongly

associated with the cellular indication of an asthmatic condition with a potential for persistent pulmonary inflammation. Therefore, exposure to the AgNPs is associated with an inflammatory response similar to asthmatic conditions in the lung.

The study focused on the 24-hour post-exposure effects of the different silver preparations. However, to further evaluate the effect of Ag NPs at different time points should be done at longer post-exposure days such as (1, 3, 7, and 21 days post-exposure). For future studies, the evaluation of the long-term pulmonary effects of AgNP exposure should be examined. The intention of this study is to see the effects of different silver nanoparticle preparations on the long due to inhalation exposure which is growing in consumer products. Possibly further continuation of research on nanoparticles could result in regulation for consumer or commercial and industrial for safe usage of this chemical.

### ***Acknowledgment***

I would like to thank all my peers and staff members at the Center for Health and the Environment (CHE) and special thanks to Dr. Pinkerton for making this research opportunity possible for me by being a great mentor and guide who gave me a chance to be part of this research opportunity to learn a variety of techniques and evaluation and analysis of the results. As well as the opportunity to present my research at both the Undergraduate Research Conference (URC) at UC Davis as well as presenting the research poster at the national conference of the American Thoracic Society (ATS) 2023 in Washington DC. Being part of Pinkerton Lab at CHE was a great opportunity for me to learn more about laboratory techniques and the research industry.

## Poster Presented At URC And ATS

# Pulmonary Effects of Silver Nanoparticle Preparations by Size, Shape and Chemical Composition

Pernelle Chan, Anita Akef, Jesus Magaña, Priya Upadhyay, Xiaohao Li, Kent E. Pinkerton  
University of California, Davis, CA 95616

UC DAVIS  
Institute of the Environment

## Introduction

- Silver Nanoparticle (Ag NP) are classified as airborne particles with a diameter < 100 nm
- Ag NPs containing silver are critical to various industrial, biomedical, and consumer products such as medical equipment (and control) due to their antimicrobial properties
- Similarly, Ag NPs enclosed in silica shell – known as silver silicate (Ag@SiO<sub>2</sub>) particles – have also been used in various commercial applications
- Ag NPs can enter the body via inhalation, ingestion, and dermal absorption
  - In 2014, the healthcare market produced the largest usage of Ag NP applications
  - Long term health effects of exposure to Ag NPs and other engineered nanoparticles have not been clearly defined for understanding

## Results

**Ag NP uptake in macrophages**

Ag NP Size	Ag NP Uptake
15 nm Ag@SiO <sub>2</sub>	~1.0
20 nm Ag NP	~1.5
110 nm Ag NP	~2.5

**Ag NP uptake in epithelial cells**

Ag NP Size	Ag NP Uptake
15 nm Ag@SiO <sub>2</sub>	~1.0
20 nm Ag NP	~1.5
110 nm Ag NP	~2.5

## Conclusions

- All three populations of Ag NPs demonstrated significant cellular uptake, predominantly in macrophages, with varying degrees of inflammation in the lungs.
- 110 nm Ag NP preparation produced the greatest influx of total cells, including alveolar and lymphocyte in the lungs.
- An influx of macrophage and lymphocyte is strongly associated with cellular indications of an inflammatory condition and the formation of granuloma in the lungs.

### Future Directions

- To evaluate the effect of Ag NPs of different shapes on the performing macrophages of lungs cells and exposure (1, 3, 7, 14, and 21 days post-exposure).
- Examining the long-term pulmonary effects of Ag NP exposure.
- Continue further research on NP regulation for consumer, commercial, and industrial safe usage.

## Methods

12 Sprague-Dawley Rats  
6 Males, 6 Females

1. Ag NP Preparation  
2. Inhalation (10)  
3. 74 hours  
4. Sacrifice

15 nm Ag@SiO<sub>2</sub>  
20 nm Ag NP  
110 nm Ag NP

5. Collection of bronchoalveolar lavage fluid (BAL) for cytotoxicity tests  
6. Lung function and morphology, including lung function tests  
7. Immunohistochemistry on sections and lung function tests

## References

- Maek, A. K., Pinkerton, K. (2006). Health effects of inhaled engineered and natural nanoparticles. Critical Reviews in Toxicology, 36(8), 699-744. DOI: 10.1080/10409170600610278
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002
- De Maessene, V., Fagnano, S. (2010). Nanoparticles: Routes of Entry, Mechanisms of Response, Biomarkers and its Role in the Toxicity Evaluation. Toxicology, 266(1-2), 1-10. DOI: 10.1016/j.toxic.2010.04.002

## Acknowledgements

This research was supported in part by NIH-NIEHS U01 ES027235 and the Undergraduate Public Health Centers program.

We thank the Pinkerton laboratory who assisted us throughout the research process. Special thanks to Dr. Pinkerton and Dr. Upadhyay for giving this valuable opportunity possible to undergraduate – we are extremely thankful for their constant support, understanding, and encouragement.

Image of me performing necropsy on mice where I was able to remove the left lung from the animal body without rupturing any tissues which was a great success.





## References

- Anderson, D. S., Silva, R. M., Lee, D., Edwards, P. C., Sharmah, A., Guo, T., Pinkerton, K. E., and Van Winkle, L. S. (2014).
- Beltran-Huarac, Juan, Zhenyuan Zhang, Georgios Pyrgiotakis, Glen DeLoid, Nachiket Vaze, and Philip Demokritou. 2018. 'Development of reference metal and metal oxide engineered nanomaterials for nanotoxicology research using high throughput and precision flame spray synthesis approaches', *NanoImpact*, 10: 26-37.
- De Matteis V. *Exposure to Inorganic Nanoparticles: Routes of Entry, Immune Response, Biodistribution and In Vitro/In Vivo Toxicity Evaluation. Toxics. 2017 Oct 17;5(4):29. DOI: 10.3390/toxics5040029. PMID: 29051461; PMCID: PMC5750557*
- Ferdous, Z., & Nemmar, A. (2020). Health Impact of Silver Nanoparticles: A Review of the Biodistribution and Toxicity Following Various Routes of Exposure. *International Journal of Molecular Sciences*, 21(7). <https://doi.org/10.3390/ijms21072375>
- González-Vega, J. G., García-Ramos, J. C., Chavez-Santoscoy, R. A., Castillo-Quñones, J. E., Arellano-Garcia, M. E., & Toledano-Magaña, Y. (2022). Lung Models to Evaluate Silver Nanoparticles' Toxicity and Their Impact on Human Health.

- Nanomaterials*, 12(13). <https://doi.org/10.3390/nano12132316>
- Madl, A.K., Pinkerton, K. (2009). *Health Effects Of Inhaled engineered and incidental nanoparticles. Critical Reviews in Toxicology*, 39:8, 629-658, DOI: 10.1080/10408440903133788
- Marassi, V., Di Cristo, L. et al. *Silver nanoparticles as a medical device in healthcare settings: a five-step approach for candidate screening of coating agents. R Soc Open Sci.* 2018 Jan 31;5(1):171113. DOI: 10.1098/rsos.171113. PMID: 29410826; PMCID: PMC5792903.
- National Research Council. 2012. *A Research Strategy for Environmental, Health, and Safety Aspects of Engineered Nanomaterials*. Washington, DC: The National Academies Press. DOI: 10.17226/13347.
- Zhang, F., Liu, G., Shen, W., & Gurunathan, S. (2016). Silver Nanoparticles: Synthesis, Characterization, Properties, Applications, and Therapeutic Approaches. *International Journal of Molecular Sciences*, 17(9). <https://doi.org/10.3390/ijms17091534>
- Technavio (2015). *Silver nanoparticle market*.
- Wang, X., Ji, Z., Chang, C. H., Zhang, H., Wang, M., Liao, Y.-P., Lin, S., Meng, H., Li, R., Sun, B., et al. (2013). *Use of coated silver nanoparticles to understand the relationship of particle dissolution and bioavailability to cell and lung toxicological potential. Small*



(Weinheim an der Bergstrasse, Germany) 10, 385–398.

- Hasegawa-Baba, Y., Kubota, H., Takata, A., & Miyagawa, M. (2014). Intratracheal Instillation Methods and the Distribution of Administered Material in the Lung of the Rat. *Journal of Toxicologic Pathology*, 27(3-4), 197-204. <https://doi.org/10.1293/tox.2014-0022>
- Huynh, H., Upadhyay, P., Lopez, C. H., Miyashiro, M. K., Van Winkle, L. S., Thomasy, S. M., & Pinkerton, K. E. (2022). Inhalation of Silver Silicate Nanoparticles Leads to Transient and Differential Microglial Activation in the Rodent Olfactory Bulb. *Toxicologic pathology*, 50(6), 763–775. <https://doi.org/10.1177/01926233221107607>
- Silva, R. M., Anderson, D. S., Franzi, L. M., Peake, J. L., Edwards, P. C., Van Winkle, L. S., & Pinkerton, K. E. (2015). Pulmonary Effects of Silver Nanoparticle Size, Coating, and Dose over Time upon Intratracheal Instillation. *Toxicological Sciences*, 144(1), 151-162. <https://doi.org/10.1093/toxsci/kfu265>
- Sung, J. H., Ji, J. H., Yoon, J. U., Kim, D. S., Song, M. Y., Jeong, J., Han, B. S., Han, J. H., Chung, Y. H., Kim, J., Kim, T. S., Chang, H. K., Lee, E. J., Lee, J. H., & Yu, I. J. (2008). Lung function changes in Sprague-Dawley rats after prolonged inhalation exposure to silver nanoparticles. *Inhalation Toxicology*, 20(6), 567–574. <https://doi.org/10.1080/08958370701874671>

Zhang XF, Liu ZG, Shen W, Gurunathan S. Silver Nanoparticles: Synthesis, Characterization, Properties, Applications, and Therapeutic Approaches. *Int J Mol Sci.* 2016 Sep 13;17(9):1534. doi: 10.3390/ijms17091534. PMID: 27649147; PMCID: PMC5037809.

## SPECTROSCOPIC DETECTION OF HUANGLONGBING

GRANT HUEZ



---

*WRITER'S COMMENT: Two years ago I received an opportunity to work at Professor Gilchrist's laboratory on campus. Through my work, I experienced first hand the techniques researchers use to study disease in plants. The disease we currently study is called Pierce's disease, a bacterial infection of grape plants. When I took a class on plant pathology in spring 2023, I learned about a citrus disease called huanglongbing. The ecology of the two diseases is fascinatingly similar, and I began to wonder about the scientific techniques for researching and managing the latter. At the same time, I took Professor Goodman-Bide's UWP 102B course on scientific writing. The course's largest assignment was a review of the latest scientific literature on any subject in biology. To satisfy my curiosity, I settled on the methodology of huanglongbing detection as my review's topic. I then narrowed the review's scope to three nonstandard methods to detect huanglongbing that all utilize spectroscopy. Huanglongbing's spread makes new techniques like these essential for continued citrus production. I hope this review interests you!*

*INSTRUCTOR'S COMMENT: For the main assignment in UWP 102B Writing in the Biological Sciences, students write a literature review. They choose their own topics, with the goal of sharing the most recent and pertinent research. It's great when students find a topic that makes a connection between classes they've taken, lab work they've done, and personal interest because that combination often provides more depth to the final work. Grant's review on new methods of detection of Huanglongbing, or citrus greening disease, shows that depth,*

*in both the research and in the writing. He explains the impact of Huanglongbing on citrus production and the problems with the most widely used diagnostic (qPCR) for the disease. Then, he introduces and describes multispectral imaging as a promising avenue for diagnosis of citrus greening. Grant's review helps readers understand one of the many plights facing crops today and reminds us of the importance of looking at problems in new ways in order to find new solutions.*

*-Amy Goodman-Bide, University Writing Program*

## Introduction

**H**uanglongbing (HLB) is a destructive disease of *Citrus* spp. (including orange, lemon, and grapefruit), that has spread through Africa, Asia, and the Americas (Sanchez et al., 2020). Since its introduction to Florida, HLB has been responsible for halving the state's share of national citrus production, once nearly 80% (USDA). Nationally, from 2007-2018, HLB caused American production of processing oranges to drop by 72% (Dala-Paula et al., 2019). The disease is caused by a bacterial infection of the tree's phloem, part of its vascular system. Said bacteria is mainly spread tree to tree by an insect vector, the Asian citrus psyllid (Sanchez et al., 2020 and Valdés et al., 2016).

Because HLB is nearly incurable, managing it is only possible with the early detection and quarantine of infected trees (Deng et al., 2020). Unfortunately, detecting HLB is not easy, since visually identifiable symptoms may take up to a year to appear, and can be confused with other ailments (Valdés et al., 2016).

Currently, the gold standard for disease diagnosis is quantitative polymerase chain reaction (qPCR) analysis (Dadras-Javan et al., 2019, Valdés et al., 2016, and Sanchez et al., 2020). However, qPCR is costly, labor intensive, and it requires destruction of plant tissue (Deng et al., 2020, and Valdés et al., 2016). Consequently, researchers are studying alternative diagnostic methods that use

spectroscopy to detect how HLB changes its host. These methods include multispectral imaging, which analyzes visual and infrared wavelengths of light, Raman spectroscopy, which analyzes light with a laser backlight, and mass spectrometry, which identifies the charge to mass ratio of molecules in the plant. This review will discuss how these methods compare to qPCR, and what role they could play for HLB surveillance.

### **Current HLB Detection Method: qPCR**

Quantitative polymerase chain reaction (qPCR) is the standard test for diagnosing many infectious diseases, including HLB (Sanchez et al., 2020). The reaction works by selectively copying a chosen sequence of DNA numerous times. For diagnosing HLB, researchers use qPCR to amplify one of the multiple DNA segments unique to the bacterial species that cause HLB, *Ca. Liberibacter* spp. (Valdés et al., 2016).

The main limiting factor for deploying qPCR en masse in commercial orchards is its cost (Dadrass-Javan et al., 2019). In order to perform qPCR, DNA must be extracted from the suspect plant tissue in a laboratory. Although little tissue is needed, qPCR diagnosis still requires transporting and destroying the infected tissue. Additionally, once the DNA is extracted, the enzymes required to perform qPCR are expensive and single use. The combined process of transportation, extraction, and analysis is time consuming, labor intensive, and cost inefficient (Dadrass-Javan et al., 2019).

Another drawback of qPCR diagnosis is its inconsistency. During early infection, the distribution of *Ca. Liberibacter* spp. is not uniform throughout the plant (Sanchez et al., 2019). Consequently, an infected plant may provide tissue samples without detectable levels of the bacteria. For the same reason, qPCR can also be inconsistent seasonally, because the bacteria's distribution changes with temperature (Sanchez et al., 2020).

Overall, qPCR is the current standard for diagnosis.

Regrettably, its expense, impracticality, and inconsistency limit its commercial application.

## **Multispectral Imaging**

Multispectral imaging is an alternative method for surveying plant diseases, which can be applied at scale, at a distance, and for a relatively low cost. Unlike qPCR, which detects the pathogen's DNA, multispectral imaging detects the plant's symptoms through machine analysis of visual and infrared images of infected trees (Deng et al., 2020). The main advantage of multispectral imaging is its non prohibitive cost. Multispectral imaging does not require sample transportation and destruction, like qPCR does. Nor does it require a costly DNA extraction and analysis. Furthermore, multispectral imaging technology is commercially available for monitoring plant health (Dadrass-Javan, 2019).

Because multispectral imaging is possible at range, an unmanned aerial vehicle (UAV) with attached multispectral camera is an attractive low cost option for en masse detection of HLB with acceptable accuracy (Dadrass-Javan, 2019, Deng et al., 2020, and Moriya et al., 2019). Dadrass-Javan et al. (2019), working in Iran, achieved over 80% accurate detection of plants showing HLB symptoms with a UAV multispectral imaging system. Another UAV system was used by a team in China, and achieved between 70% and over 90% accuracy for detecting symptomatic plants, depending on the analysis software used (Deng et al., 2020). On the contrary, a study in Brazil that used a similar method reported an accuracy of only 62% (Moriya et al., 2019). These experiments show that multispectral imaging using a UAV is a quick and cheap way to detect citrus with HLB symptoms. Although the accuracy is not consistently high, and not all infected plants are symptomatic, this technique may be valuable for estimating disease incidence and yield loss.

Satellite multispectral images have also been analyzed for use in detecting HLB. Initial experiments for identifying symptomatic

trees met with limited success due to low resolution (Li et al., 2015). However, more recent research indicates that satellites may have a use for identifying infested orchards (Yzquierdo-Alvarez et al., 2021).

Multispectral imagery's capacity for quick, large scale surveys defines its role in HLB surveillance. Its accuracy is lower than other detection methods, and it can only detect HLB once symptoms are present. Nonetheless, the speed and low labor cost of multispectral imaging, when deployed by UAV, make it an attractive means for growers in affected areas to estimate HLB incidence.

### **Raman Spectroscopy**

Raman spectroscopy is a technique that is relatively novel to plant disease diagnosis, but is showing promise for detecting HLB consistently and early in infection. Raman spectroscopy is a laser based method that detects the chemical composition of a given substance (Sanchez et al., 2019). The spectrometers are composed of a detector and a laser. The laser shines light onto the sample which scatters into different wavelengths depending on chemical bonds in the sample. Then, the detector analyzes the scattered light and outputs the sample's wavelength spectrum as a reading (Pérez et al., 2016). HLB is detected by observing chemical changes caused by the disease.

Because the spectrometer is simply shining light on the tissue sample, the test is noninvasive, so no sample is destroyed. Furthermore, the device is portable, able to go wherever sampling is required (Pérez et al., 2016 and Sanchez et al., 2019).

In recent years, several research teams have experimented with using handheld Raman spectrometers to diagnose HLB. In Mexico, Pérez et al., (2016) examined citrus trees using Raman spectroscopy and qPCR. Sanchez et al., (2019) conducted the same experiment on citrus leaves in Texas. Liu et al., (2020) applied these techniques in China. With the spectrometers, the research teams each identified significant spectral anomalies between HLB positive and negative

plants to build their models (Liu et al., 2020, Pérez et al., 2016 and Sanchez et al., 2019). The anomalies they identified include readings associated with dropping carbohydrates, increasing lipids and a changing polyphenolic and carotenoid profile. While the different studies observed the same spectral differences, the exact assignments of chemicals to wavelengths was not entirely consistent among the studies (Liu et al., 2020, Pérez et al., 2016 and Sanchez et al., 2019). Each group also created their own statistical models, incorporating every anomaly they found, to categorize samples as healthy or infected.

Across the three studies, their best Raman spectroscopy statistical models correctly identified HLB infected tissue 85% to 100% of the time when compared to qPCR (Liu et al., 2020, Pérez et al., 2016 and Sanchez et al., 2019). Comparing qPCR and Raman spectroscopy with statistical analysis, the latter maintains high accuracy, despite a significantly decreased materials and labor cost.

Raman spectroscopy is also able to detect early, pre-symptomatic or slightly symptomatic HLB infections (Liu et al., 2020 and Sanchez et al., 2019). In the above research, Raman spectra produced by the plant were shown to not differ drastically from early infection to late infection (Sanchez et al., 2019). To measure early-diagnosis capability, Sanchez et al., (2020) monitored initially healthy orange and grapefruit trees with qPCR methods and also Raman spectroscopy. They found that Raman spectroscopy detected HLB even before qPCR detected the presence of the pathogen (Sanchez et al., 2020). Although this particular finding was derived from only four tree samples, it is promising. More research is needed to know if Raman spectroscopy can consistently detect HLB before qPCR. Regardless, the ability to detect pre-symptomatic HLB is valuable. Therefore, Raman spectroscopy's rapid results, portability, decent accuracy, and lower cost than qPCR could make it a convenient tool for surveillance of HLB in the field.



## **Mass Spectrometry**

Mass spectrometry (MS) is a technique for identifying different chemicals present in a sample (Pontes et al., 2020). MS measures the charge/mass ratio of molecules inside the sample tissue. As with qPCR, MS requires the destruction of the sample. In common with Raman spectroscopy and multispectral imaging, MS detects chemical changes in the plant in response to HLB. A distinction of MS compared to multispectral and Raman spectroscopy is MS' ability to identify the particular metabolites a plant produces, instead of broad molecular groups (Pontes et al., 2020). This specificity is useful in research because it identifies what specific molecules the plant is producing during HLB infection. MS' specificity may also provide a higher accuracy in diagnosing HLB, including pre-symptomatically (Li et al., 2019 and Valdés et al., 2016).

MS readings identify differences between healthy and infected tissue. Li et al., (2019) demonstrated that infected leaf tissue has a concentration change in ions of  $m/z$  1259, 649, and 381. The researchers believe the 1259 and 649 readings come from potassiated flavonoids (a class of plant secondary metabolites), while the 381 reading reflects a change in the levels of sucrose (a carbohydrate), also bound to potassium (Li et al., 2019). Pontes et al., (2020) corroborates the changing sucrose level with an MS reading at 343 (no potassium). The same group also found infected leaves concentration differences in phenylalanine, an amino acid, and nobiletin, a flavonoid, among other chemicals that could be used as biomarkers of HLB (Pontes et al., 2020). By identifying these chemical differences, mass spectrometry with statistical analysis can reveal the presence of HLB.

MS diagnosis also appears effective throughout the seasons. Li et al., (2019) used principal component analysis, a statistical method, on the MS results, sorted healthy and diseased tissue into distinct groups. The researchers notably found that MS results were able to discern healthy plants from infected ones no matter the

season (Li et al., 2019). This is an advantage over qPCR, which can struggle to diagnose HLB during the summer months (Sanchez et al., 2020). However, like qPCR, MS' commercial application as a diagnostic for HLB may be hindered by its labor cost, and the limited availability of portable options. Rather, the value of MS might be in the laboratory, as a complement to qPCR during the summer.

## **Conclusion**

This review's purpose was to highlight spectroscopic methods that can diagnose the presence of HLB. Current research into multispectral imaging, Raman spectroscopy, and mass spectrometry shows that these methods, with statistical analysis, can distinguish between healthy and infected plant tissue. Research into multispectral imagery shows how this already commercially available method can quickly survey large areas en masse for estimates of disease incidence. Research into Raman spectroscopy gives some evidence that it can detect infection even earlier than qPCR. Finally, research into mass spectrometry, a tool for chemical identification, shows it can diagnose HLB throughout the seasons. Ultimately, managing plant disease is an economic question, and the cost analysis of these methods is not truly known until they are used commercially. Regardless, these spectroscopic methods have promise streamline and lower costs for the detection of HLB in the field. Successfully implementing these methods in commercial orchards should be further researched.

## References

- Dadrass-Javan F, Samadzadegan F, Pourazar S, Hossein S. 2019. UAV-based multispectral imagery for fast Citrus Greening detection. *J Plant Dis Prot.* 126: 307-318. <https://doi.org/10.1007/s41348-019-00234-8>
- Dala-Paula B, Plotto A, Bai J, Manthey JA, Baldwin E, Ferrarezi RS, Gloria MBA. 2019. Effect of Huanglongbing or Greening Disease on Orange Juice Quality, a Review. *Front Plant Sci.* 9: 1976. <https://doi.org/10.3389/fpls.2018.01976>
- Deng X, Zhu Z, Yang J, Zheng Z, Huang Z, Yin X, Wei S, Lan Y. 2020. Detection of Citrus Huanglongbing Based on Multi-Input Neural Network Model of UAV Hyperspectral Remote Sensing. *Remote Sens.* 12(17): 2678. <https://doi.org/10.3390/rs12172678>
- Li W, Yao YN, Wu L, Hu B. 2019. Detection and Seasonal Variations of Huanglongbing Disease in Navel Orange Trees Using Direct Ionization Mass Spectrometry. *J Agric Food Chem.* 67(8): 2265-2271. <https://doi.org/10.1021/acs.jafc.8b06427>
- Li X, Lee WS, Li M, Ehsani R, Mishra AR, Yang C, Mangan RL. 2015. Feasibility study on Huanglongbing (citrus greening) detection based on WorldView-2 satellite imagery. *Biosyst Eng.* 132: 28-38. <https://doi.org/10.1016/j.biosystemseng.2015.01.009>

- Liu Y, Xiao H, Hao Y, Ye L, Jiang X, Wang H, Sun X. 2020. Diagnosis of Citrus Greening using Raman Spectroscopy-Based Pattern Recognition. *J Appl Spectrosc.* 87: 150-158. <https://link.springer.com/article/10.1007/s10812-020-00976-6>
- Moriya EAS, Imai NN, Tommaselli AMG, Berveglieri A, Honkavaara E, Soares MA, Marino M. 2019. DETECTING CITRUS HUANGLONGBING IN BRAZILIAN ORCHARDS USING HYPERSPECTRAL AERIAL IMAGES. *ISPRS.* 42: 1881-1886. <https://doi.org/10.5194/isprs-archives-XLII-2-W13-1881-2019>
- Pérez MRV, Mendoza MGG, Elías MGR, González FJ, Contreras HRN, Servín CC. 2016. Raman Spectroscopy an Option for the Early Detection of Citrus Huanglongbing. *Appl Spectrosc.* 70(5): 829-839. <https://doi.org/10.1177/0003702816638229>
- Pontes JGM, Vendramini PH, Fernandes LS, de Souza FH, Pilau EJ, Eberlin MN, Magnani RF, Wulff NA, Fill TP. 2020. Mass spectrometry imaging as a potential technique for diagnostic of Huanglongbing disease using fast and simple sample preparation. *Sci Rep.* 10: 13457. <https://doi.org/10.1038/s41598-020-70385-4>

- Sanchez L, Pant S, Mandadi K, Kuroski D. 2020. Raman Spectroscopy vs Quantitative Polymerase Chain Reaction In Early Stage Huanglongbing Diagnostics. *Sci Rep.* 10: 1010. <https://doi.org/10.1038/s41598-020-67148-6>
- Sanchez L, Pant S, Xing Z, Mandadi K, Kurouski D. 2019. Rapid and noninvasive diagnostics of Huanglongbing and nutrient deficits on citrus trees with a handheld Raman spectrometer. *Anal Bioanal Chem.* 411: 3125-3133. <https://doi.org/10.1007/s00216-019-01776-4>
- Simnitt S, Kramer J. 2020. Citrus Greening Disease caused falling production in Florida, but production is forecast to stabilize in 2019/20. United States Department of Agriculture Economic Research Service; [accessed 2023 May 17]. <https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=98417#:~:text=Since%20HLB%20arrived%20in%20Florida,to%20less%20than%2042%20percent>
- Valdés RA, Ortiz JCD, Beach MB, Cabello JA, Chávez EC, Pagaza YR, Fuentes YMO. 2016. A review of techniques for detecting Huanglongbing (greening) in citrus. *Can J Microbiol.* 62(10): 803-811. <https://doi.org/10.1139/cjm-2016-0022>

Yzquierdo-Alvarez, Estefania M, Ortiz-García, Fredy C, Rincón-Ramírez, Alberto J. 2021. Detection of huanglongbing of citruses (*Citrus* sp.) through Sentinel-2 satellite images in Huimanguillo, Tabasco, Mexico. *Agro Productividad*. 14(12): 119-126. <https://doi.org/10.32854/agrop.v14i12.2053>

We are pleased to announce the 35th Annual Prized Writing competition. This competition is designed to find the best writing produced by UC Davis undergraduates during the 2023–2024 academic year.

Contestants must be undergraduates whose work was written for a UC Davis course during the 2023–2024 academic year beginning with Summer Session I, 2023.

**Deadlines for 2023-2024**

For Summer Session and Fall Quarter Classes: December 22, 2023

For Winter Quarter Classes: March 29, 2024

For Spring Quarter Classes: June 14, 2024

For full details, please see the contest rules on our website:

**[prizedwriting.ucdavis.edu](https://prizedwriting.ucdavis.edu)**

Anita Akef  
Sofia De Angelis Borghesi  
Audrey Bridges  
Joseph Brockly-Anderson  
Jake Campo  
Chi Chen  
Jillian Clark  
Amber Dekker  
Holly Eberhard  
Lev Gordon-Feierabend  
Tan N Hua  
Grant Huez  
Sophie Jorcino  
Sofie Kanayama  
Manpreet Kaur  
Annie Mlyadi  
Richard Pham  
Dylan Rogers  
Timothy Shen  
Daphne Tang  
Samantha Vanpelt  
Nkauj Hmoob H Vue  
Eden Winniford  
Madison J. Wong  
Isaac Yu