WILDFIRE

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ABSTRACT

Wildfire is a 48-foot long speaker array that plays back a wave of fire sounds across its 48-foot span at speeds of actual wildfires. The sound art installation strives to have viewers embody the devastating spread of wildfires through an auditory experience.

1. INTRODUCTION

Over the past five years, 5.4 percent of California state's acreage has burned.[1] Seven of the state's largest fires have occurred in the last ten years. In 2018 alone, wildfires burned the largest amount of recorded acreage and included the deadliest fire on record, Camp Fire, which destroyed the city of Paradise and took 88+ lives.[2] How can we better understand our relationship to wildfires through listening? How can sound help us understand the environment of western states, like California, in particular? Building from the study of ecoacoustics—using sound to build relationships between us and our environments—*Wildfire* employs sound to investigate how the climate enables destructive wildfires that lead to statewide emergencies. The speed at which fires move can be mimicked in sound. By placing speakers every three feet across 48 feet (16 speakers), *Wildfire* implements spatialization techniques to play waves of fire sounds at realistic speeds of simulated and actual wildfires. Comparing the speed of different fires through sound spatialization, we can hear how quickly different fires move across various geographic conditions (fuel, topography, and weather).

2. BACKGROUND

Wildfire follows a line of environmental sound works that explore different themes of human impact on climate. Ecoacoustic compositions, like Andrea Polli's "Sonifications of Global Environmental Data," rely on the translation of data to sound (sonification) in order to communicate storm and climate changes.[3] Musical works, like Matthew Burtner "Auksalaq" (Inuit word for melting snow/ice), use scientific information to create scores for performers on acoustic instruments.[4] As an Environmental Resilience and Sustainability scholar at the University of Virginia, I worked with John Reagan and John Park (College of Art and Design, University of Oregon) to create *Aqua•litative* (https://aqualitative), a kinetic sound installation that turned 40 years of California water history into a gallery experience.[5] In *Wildfire*, I transform the natural characteristics of the environment into a sonic depiction of the destructive forces at play in western wildfires. *Wildfire* unpacks the scientific and social commentary of our human experience and environment through an aural experience. The piece was made possible through a 2019 Summer University of Oregon Center for Environmental Futures and Andrew W. Mellon Foundation Faculty Research Award.

3. GOALS

There were several objectives I had in mind when outlining *Wildfire*.

- Learn one new element (technology, method, skill) that strengthens my creative practice and teaching.
- 'Re-use' technology learned in previous work to help inform creative practice using speaker arrays
- Spatialize audio with accurate acoustics (doppler, phase alignment) across a multi-channel system
- Develop an installation with minimal aesthetic to help convey only the essential narrative(s) to the listener
- Install work in a gallery setting
- Install work over a period of time to help increase possibilities for interaction
- Document the work in various formats to increase touch points outside gallery space
- Continue developing a series of sound art work on environmental impact

4. THE WORK

Wildfire is comprised of sixteen 30W speakers, 120' speaker cable, sixteen 8" square wood mounts, sixteen 6.25" diameter wood speaker rings, 64 aluminum speaker post mounts, eight custom electronic boards and enclosures, eight 50W power amps, one custom mother board and enclosure, eight custom length Ethernet cables, custom-built power supply cable, sixteen 15V 4A power supplies, and three 9V 5A power supplies.

Eight different recordings of wildfire sound simulations are played across the 48-foot speaker array in looped playback. A narrator describes each wildfire event before audio playback of fire sounds. Because audio on all eight stereo channels are triggered at the same time for simultaneous playback, audio spatialization is 'baked-in' on the audio files. The fire soundscapes are audio samples that have been simulated in a virtual space to move at speeds of actual wildfires and captured (read recorded) as eight stereo audio files at the same spatial location of the sixteen speakers in the

physical world. The virtual mapping and recording process ensures little destructive interference as a result of phase shifts and time delays.

Audio 1: Stereo playback of custom fire sound spatialization on single electronics board (board 1).

Audio 2: Stereo audio example of Camp Fire narration including stereo playback of fire sound spatialization on single electronics board (board 3).

4.1. Process

I am always amazed by how differently topics are defined and vocabulary used when working across disciplines. For example, in seeking to play audio at varying rates of 'speed,' wildfire scientists and firefighters instead describe fires in terms of 'rate of spread.' Because fires are not single moving points but instead lines that can span miles moving in various directions all at once, speed is difficult for the field to put into practice. The term 'spread' and how its calculated serve wildfire science well but required me to think about how to convey the destructive 'rates of spread' as a rate a general observer may perceive along a 2D speaker array.

In order to distill wildfire science down to essential components for a gallery sound installation, I spent a lot of time speaking with various wildfire scientists on the phone, emailing various fire labs, working on estimating wildfire behavior using Rothermel's Spread Rate model,[6][7] and working between the measured distance of 'chains' and miles. The result was eight narratives that juxtapose 'common' rates depicted in simulated models with real wildfires that have occurred in US western states over the past ten years. These narratives are outlined in Table 1.

4.1.1. Reusing Technology

Earlier in the year, I worked with Harmonic Laboratory (http://harmoniclab.org), the art collective I co-direct, on a 120-speaker environmental sound work called *Awash*.[8] The work was commissioned for the High Desert Museum in Bend, Oregon as part of the Museum's 2019 Desert Reflections: Water Shapes the West exhibit, which ran from April 26 to Sept. 27, 2019. The 32' x 8' work evokes the beauty of the high desert through field recordings, timbral composition, and kinetic movement.

The electronic technology that I implemented in *Awash* for playing back audio across 120-speakers influenced my design of *Wildfire*. The piece works by sending a basic low-voltage signal from the mother board to all eight electronic boards across Ethernet cable, thereby triggering simultaneous playback of audio across all sixteen speakers (Figure 1). Instead of 3W speakers and 20W power amp boards used at the High Desert Museum, I chose to scale down the number of speakers and ramp up the wattage per board, choosing a stereo 50W power amp matched with two 30W speakers. The result is sixteen channels of audio running across eight stereo boards. Figure 5 shows the sixteen channels on the gallery wall.

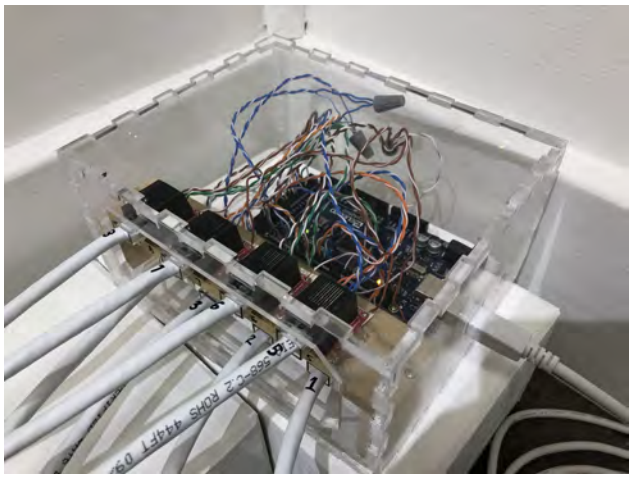

Figure 1: Wildfire motherboard (Arduino Mega2560) with eight Ethernet jacks for communication.

4.1.2. New Techniques

Wildfire enabled me to implement two new elements inside my work. The first new element was building custom laser-cut acrylic enclosures for the electronic boards (Figure 2). The second element was designing and creating custom PCB boards for the electronics themselves (Figure 3). For the custom PCB board, I learned Eagle CAD software and then used an Oregon-based manufacturer OSH Park to print the boards. I count both endeavors as huge wins to future works and within my teaching practice for assisting graduate students in constructing their own digital musical instruments as part of the doctorate program in Data Driven Instrument Performance at the University of Oregon.

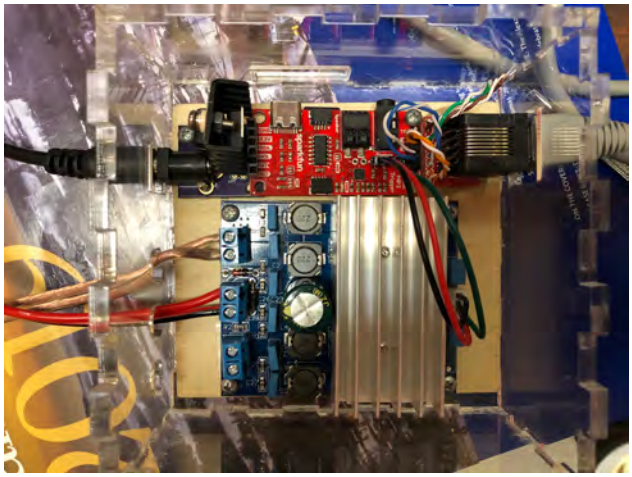

Figure 2: One of eight custom electronic modules. Custom laser-cut acrylic enclosure with TDA7492 50W power amp, Sparkfun Qwiic MP3 trigger, custom PCB power board, and Ethernet jack breakout.

Figure 3: Custom PCB board for power.

4.1.3. Woodworking

For the sixteen panel mounts and speaker rings, I sourced all wood from the wood shop at my father-in-law's, who has various wood collected over the last 50-60 years. The panels were planed, cut, and drilled on site and the speaker rings were cut using a drill press. Figure 4 depicts the raw materials after applying a basic wood varnish. The wood mounts consist of black walnut, pine, and sycamore woods. The wooden speaker rings consist of alder, ebony, and myrtle woods.

Figure 4: Wildfire wood materials for rings and speaker mounts. Wood includes alder, pine, ebony, sycamore, myrtle wood, and black walnut.

5. INSTALLATION

The work was installed at the Edith Langley Barrett Art Gallery in Utica, New York. Due to issues discussed in Section 6, the piece took four days to install. The work is up Sept. 19 – Dec. 8, 2019 as part of a solo art exhibition entitled, *Impact! works by Jon Bellona*. A silent video, which walks through the gallery exhibit and visually captures each of the six sound art works is available online (https://www.youtube.com/watch?v=e6wG-xXMS_0). A documentary video of *Wildfire* is also available online (https://www.youtube.com/watch?v=L5fSUU6SX_4).

5.1. Reception and Data Collection

While in New York, I gave a guest lecture on my work to Britt Hysell's ESOL class at Hamilton College on Thursday, Sept 19, 2019. At the opening reception of the exhibition, ninety-seven people were in attendance, including Utica College's Provost for the College, Vice Provost, various faculty and students from both Utica College and Hamilton College. I received really positive remarks stemming from a visceral response to the work. "I immediately got it." "I love the wood and sounds." "Wow." For more insightful data, the gallery is tallying visitor numbers and housing a visitor guestbook throughout the exhibition. Sarisha Hoogheem, the Collections Manager at Barrett Art Gallery, is also finishing a collections document on *Wildfire* for our records including the installation process and docent instructions for upkeep.

6. DISCUSSION

The work was not without challenges. These challenges fortunately became learning opportunities for improving *Wildfire* and for future work. For example, because of the cost incurred with AC power cords, time it took to run cables, and the cluttered look and feel of taped cables on the floor underneath the speakers, I would change the work in the future to run longer speaker cables to a central electronics location instead of running power and data cables to electronic boards near each set of stereo speakers.

In the build out, I was unable to power both the power amp and the MP3 audio boards from a single power source. A large hum was evident during the split of power when powered on along. A future test could attempt to power from a single power source while sharing ground with the mother board. Yet, the audible hum led me to power the boards separately.

During install, I ran into issues of power related to the MP3 Qwiik trigger boards. The power draw for each MP3 board is between 3 to 3.3V, I ran four boards from a single 9V 5A power supply using a custom T-tap connector cable, and I registered 3.26V along each power connection. Powering the boards was not the issue. However, upon sending a low-voltage trigger from the motherboard to the MP3 boards, I was unable to successfully trigger audio from the last board located at the end of the power supply connector cable. The problem remained consistent, even after switching modules, switching boards, testing Ethernet data cable, testing a different I2C communication protocol in the same configuration, among other troubleshooting tasks. When powering the final board with a different power supply (5V 2A), I was able to successfully trigger all eight electronic boards at once. It should be noted that the issue seems to have cascaded from my failure to effectively split power from a single power source per electronics module.

The minimal aesthetic was slightly hindered due to the amount of data and power cables running along the floor. There is minimal noise induction with long speaker cable runs, and in the future I would choose to rely on longer speaker cable runs instead of long power and data cables. This choice would also help keep costs down, save time in dressing cables, and focus attention along the 48' span on the speakers, wood, and audio.

Table 1: Narratives in *Wildfire*

Feature	Characteristics	Rate of Spread	Time across 48-foot speaker array
Surface Fire: Grass	Low dead fuel moisture content, High wind speed, Level terrain	Upper average forward rate of spread, 894 chains/hour	2.92 seconds
Yarnell Hill Fire, June 30, 2013	3-6% dead fuel moisture content, Wind speed 15-25 mph, Mixed terrain	During Granite Mountain crew deployment, 1280 chains/hour	2.04 seconds
Crown fire: Forest	Low dead fuel moisture content, High Wind speed, Level terrain	Upper average forward rate of spread, 297.6 chains/hour	8.7 seconds
Delta Fire, near Shasta, California. September 5th, 2018	Moisture content unknown, Wind speed unknown, Mixed terrain	Initial perimeter rate of spread, 16,993 sq. chains/hour	1.54 seconds
Surface Fire: Western Grassland, Short Grass	2% Dead Fuel Moisture, Wind speed 20 mph, Level Terrain	Perimeter rate of spread, 1250 chains/hour	2.16 seconds
Long Draw Fire. Eastern Oregon. July 12, 2012	Moisture content unknown, Wind speed unknown, Mixed terrain	Average perimeter rate of spread, 61,960 sq chains/hour	0.422 seconds
Crown Fire: Pine and Sagebrush	2% Dead Fuel Moisture, Wind speed 20 mph, Level Terrain	Perimeter rate of spread 525 chains/hour	4.99 seconds
Camp Fire, near Paradise California. November 8th 2018.	Low Moisture content, Wind speed 50 mph, Mixed terrain	Peak perimeter rate of spread, 67,000 sq. chains/hour	0.394 seconds

Figure 5: View of *Wildfire* in Barrett Art Gallery (2019).

7. CONCLUSION

Through the active listening experience of hearing sounds of wildfires at realistic speeds, viewers are openly invited to support sustainable and resilient policies, including ones that can be done immediately, like creating defensible space around their homes. In the face of continued ongoing wildfires that become more frequent, *Wildfire* sonically strives to impact the listener in registering the devastation caused by wildfires. Getting the public to support sustainable policies and/or individually prepare for wildfires helps make communities more resilient to the impacts of wildfires and other disaster-related phenomena caused by climate change.

8. ACKNOWLEDGMENT

The work was made possible through the University of Oregon Center for Environmental Futures and the Andrew W. Mellon Foundation. The *Impact!* exhibition at the Barrett Art Gallery was supported with funds from the Oregon Arts Commission. Thank you to Meg Austin for inviting me to display work at the Barrett Art Gallery, and I am indebted to Sarisha Hoogheem and Matthew Klausner for their hard work in putting the show together. Thank you to my cousin John Bellona, a career Nevada firefighter, for his insight on western wildfires and contacts in the field. Thank you to Dr. Mark Finney for providing common averages of speed related to wildfires; Dr. Kara Yedinek for sharing insights on audio frequencies from her fire research; and Sherry Leis, Jennifer Crites, Janean Creighton and the other fire specialists who helped me along the way.

9. REFERENCES

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Figure 6: View of *Wildfire* in Barrett Art Gallery (2019).

Figure 7: View of four *Wildfire* speakers with wood ring and mounts.