

California wildfire burns boundaries between science and art

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From proposal to execution, the Across the Channel: Investigating Diel Dynamics (ACIDD) mission was anything but traditional. To begin with, ACIDD featured two PhD students as co-principal investigators and chief scientists, and was conceived, planned, and executed by these two students along with a science team composed almost entirely of their graduate student peers at UC Santa Barbara (UCSB). ACIDD was scheduled to take place in the Santa Barbara Channel (SBC) from December 16 to 22, 2017 aboard the R/V *Sally Ride* and would be carried out by a full complement of 21 scientists and 3 artists. Our team had spent much of 2017 developing science plans, preparing artistic products, and organizing sampling schemes for ACIDD with the objective of examining daily microbial, chemical, and biological variability.

Our team was presented with a rare opportunity with the breakout of the Southern California Thomas Fire in early December 2017. Wildfires are unpredictable events and it is logistically challenging to secure time at sea aboard research vessels to measure the effects fires have on marine ecosystems. Research cruises must be scheduled months to years in advance, but wildfires can ignite and spread in minutes to days. The ignition of the Thomas Fire and the subsequent ash deposition over the ACIDD study region motivated our team to incorporate a direct investigation of how dry ash deposition impacts the coastal oceanic ecosystem with a focus on microbial

processes. A pre-existing collaboration with a team of artists became instrumental to share insights with the community in light of the devastation caused by the fire.

This commentary addresses the value of student leadership in conceiving, adapting, and executing cruise plans during the Thomas Fire and the far-reaching connection with the public that grew out of the coupled artistic-oceanographic pursuit.

The ACIDD mission sought to contribute fundamental knowledge about diel processes in the Santa Barbara Channel, a site with decades of oceanographic research on monthly time scales. Co-PIs Baetge and Bisson also envisioned an opportunity to share this knowledge with a diverse public audience to stimulate environmental curiosity and engagement. While oceanographic publications are read worldwide, they are available to an extraordinarily limited readership with access to the proper resources and an understanding of scientific jargon. This perspective challenged our team to think more creatively about the ways in which oceanography could be communicated to a broader population. With the motivation of gaining a deeper understanding of the SBC and inclusion of a diverse public community, Baetge and Bisson submitted a collaborative proposal to the University of California Ship Fund program that involved the participation of their fellow doctoral students in the Interdepartmental Graduate Program for Marine Science (IGPMS) at UCSB.

The University of California (UC) Ship Funds program, established in 1995, awards sea time aboard Scripps Institution of Oceanography (SIO) research vessels to proposals that enable practical research training of undergraduate, graduate, and early-career scientists from UC Santa Barbara, UC Santa Cruz, and UC San Diego. This fund offsets the costs of expensive (up to ~\$40,000/day) ship operations and allows students to assume leadership roles to plan and execute

a successful research cruise. The submitted proposal for ACIDD outlined our plan to examine fluctuations in microbial, chemical, and biological cycles on daily scales.

After the UC Ship Funds proposal was submitted, Bisson led a proposal to the National Academies Keck Futures Initiative (NAKFI) to fund activities and products designed to bring oceanographic research to the greater public. The UCSB team, together with artists Jacobs, Hayes, and Girling, created ROAM (Rendering Oceanography through Artistic Mediums), to bring oceanography to the public eye through art, music, photography, writing, and film. Experiencing the methods of science through art offers an entry point for the public to examine scientific findings with greater transparency, often spurring more questions from non-experts and allowing for deeper trust in the scientific process. The tradition of American oceanographic research has not typically included artists at sea in the academic fleet, although more generally, art and science have often been coupled (e.g., Joppien and Smith, 1987; Tara Oceans expedition, <<https://oceans.taraexpeditions.org/en/m/art/>>, Schmidt Ocean Institute, <https://schmidtoccean.org/apply/artist-residency-program/>). Such collaborations help to challenge discipline-specific paradigms, which can push the boundaries of knowledge through new ways of thinking.

In early 2017, we learned that both the UC Ship Funds and NAKFI proposals were successfully funded. Much of the planning thereafter included the acquisition of further funding to support consumable, analytical, and art-rendering costs. Our science team met weekly and worked closely with SIO administrative and technical personnel to negotiate logistics, including transportation, space allocation, berths, CTD rosette deployment schemes and water budgets, minute-by-minute ship operation schedules, contingency plans, and experimental designs. The teams were met with

75 the same challenges and obstacles of any major oceanographic program, from limited financial
76 budgets to apparent deadlocks in scientific and logistical discussions. We were tasked to adjust
77 our scientific objectives around the resources we had without abandoning our fundamental
78 directive or jeopardizing the quality of science. We were feeling as prepared as possible with a
79 few weeks remaining before we would all gather in San Diego for mobilization. Then, on
80 December 4, 2017, ten days before mobilization, the Thomas Fire ignited in the Santa Barbara
81 mountains. Fanned by oceanward Santa Ana winds, the fire roared through the dry coastal
82 vegetation and burned 63,000 acres overnight.

83 The Thomas Fire ultimately burned for over one month, scorching nearly 282,000 acres of private,
84 agricultural, and public land as well as over 1,000 structures throughout Ventura and Santa Barbara
85 Counties (CAL FIRE; fire.ca.gov). At the time, it was the largest wildfire in California's recorded
86 history. Strong Santa Ana Winds carried thick plumes of smoke, ash, and soot westward over our
87 study site in the coastal Pacific Ocean. In the week following the ignition of the Thomas Fire, the
88 ACIDD team realized that the ecosystem we had anticipated studying was likely impacted by the
89 Thomas Fire. In the last 20 years, fire frequency in southern California has increased, altering
90 native chaparral ecosystem composition (Syphard et al., 2018). Though the impacts of wildfire ash
91 on freshwater quality and watershed ecosystems in Southern California have been documented
92 (Coombs and Melak, 2013), there have not been, to our knowledge, any oceanographic studies
93 addressing the immediate impacts of wildfire ash on marine ecosystems.

94 In the two weeks before mobilization, the science team hastily adapted plans to assess the influence
95 of wildfire ash deposition on the coastal microbial ecology. The last-minute changes invited
96 boundless creativity and discipline as our team redesigned our science questions and tested
97 methods for detecting ash (most of which were new analyses to us). Ash particles were collected

on land to run preliminary experiments, the results of which would guide our sampling strategy at sea. These experiments included measuring nutrient and dissolved organic carbon leached from ash, measuring absorption spectra of varying concentrations of ash particles and ash leachate, quantifying dry ash particle size distribution, and observing the physical behavior of ash in seawater (flocculation, sinking, and buoyancy). While some members of the ACIDD team were working in the lab, others were filming landscapes along the Santa Barbara and Ventura coasts to collect scenes that would be combined with film from the cruise. After the fire broke out, we imagined that a resulting documentary from the cruise could convey the importance of both science and art to society during times of crisis.

The moods and experiences of the Santa Barbara community during this time varied, but most of our science team members were stressed, scared, and concerned about the welfare of our friends, neighbors, and ourselves. Shifting wind directions and intensities meant rapidly-changing daily evacuation orders, with texts and calls sometimes coming in the middle of the night. Final exams for all UCSB students were rescheduled from December to January, so most undergraduate and graduate students left campus and returned home. The ACIDD team were some of the only students on campus, conducting preliminary experiments in labs and repacking gear boxes with newly-needed inventory. We worried about the health effects of breathing in ash and smoke, as well as the potential of receiving an order to evacuate our homes at a moment's notice. We waited for news and wondered if our cruise would be cancelled. The days before mobilization, we brought aboard new members who were especially interested in collecting samples to study the real time effects of ash on microbiology. A subset of our team, David Valentine, Craig Carlson, and Debora Iglesias-Rodriguez, applied for an NSF Rapid Response Research (RAPID) grant and received

funding shortly thereafter to supplement materials for some of the work planned in response to the fire.

On our mobilization date, the Thomas Fire was only 35% contained. Feeling mixed emotions, but bolstered as a team, we mobilized in San Diego and set sail for the SBC. As the ship neared the SBC, settling ash formed a layer on the exterior of the ship, like a dusting of snow, thick enough that it could be written in with a finger (Figure 1). In the days that followed, our teams worked hard together, overcoming hurdles to compile an invaluable data set and create stunning artistic representations of the mission.

Art and science both involve an exploratory phase followed by the presentation of results. Scientists are trained to communicate their work in linear, formulaic ways, such as publications that follow a formal structure (introduction, methods, results, discussion), whereas the primary product of an artistic inquiry may take many forms. The ACIDD mission aimed to elevate both approaches. While the science necessarily occurs on a slower timeline and many important discoveries are still to be published or presented from this expedition, many of the artistic endeavors evolved quickly and have already been produced.

Below, we introduce our artistic products, which highlight the intersections of art, science, society, and the rarity of studying the ocean during a natural disaster.

Sister Schools

To engage with students across geographic, socioeconomic, and age boundaries, the ACIDD team adopted 14 “Sister Schools” from Maine to Ohio to California. Each participating classroom at a Sister School was sent postcards designed by Girling and some background materials about the science and logistics of ACIDD. After teachers introduced our project to their class, each student

filled out a postcard with questions for the ACIDD team to answer while we were at sea and mailed them back to Santa Barbara. We hoped to give students an opportunity to interact with graduate student scientists despite the physical distance between most of these schools and the Santa Barbara Channel (or any ocean). Select postcards were answered and filmed at sea (available at <https://vimeo.com/projectacidd>) as part of a “Coast to Post” video series. Further communication with schools and teachers took place through Skype calls and the Project ACIDD Instagram account (https://www.instagram.com/project_acidd/).

Eco Art

Sampling materials typically used to conduct oceanographic research unavoidably require single-use plastics. These plastics contribute to man-made waste and potentially impact the ocean. To call attention to the amount and types of trash generated from oceanographic work during the Thomas Fire, we teamed up with eco-artist Reading. Reading’s paintings used the single-use trash generated during the ACIDD cruise (falcon tubes, gloves, containers, tape labels, etc.) as a canvas (Figure 2). Her hope is to generate playful and provocative pieces that can spark conversations about the process and methods of science by highlighting the quantity of non-biodegradable materials required to study our environment.

Aquatic Cathartic Documentary

As part of the effort to engage as many people as possible in the science and process of ACIDD, the art team created a 26-minute documentary titled “Aquatic Cathartic.” A short, publicly-available, documentary film style was chosen with the hope that even the most casually-curious viewer could find time to connect with oceanography and art from the convenience of their home computer. The film offers an outsider’s perspective to seagoing oceanographic research in all of

its glories and shortcomings, highlighting the similarities of life at sea to our civilian struggles and triumphs. The film also emphasizes both the importance and challenges of going to sea during the Thomas Fire. Aquatic Cathartic premiered at the Washington, D.C. Environmental Film Festival and is now freely available online (<https://vimeo.com/281882446>).

Migrations Magazine

We produced a magazine to document our work at sea. Our society has general perceptions of both art and science as disciplines, and of the separation of the work done in these disciplines. These perceptions are naturally shaped by embedded cultural values that may give inherent value to either discipline, and encourage their separation. The overall goal of the “Migrations” magazine is to flatten these hierarchies in a publication that features submissions and contributions across all career stages and disciplines of the ACIDD team (Figure 3). The pages showcase artistic renderings of scientific data juxtaposed with poetry from the science team, photography from the expedition with a focus on ash, and lyrics written aboard R/V *Sally Ride* (Figure 3). The end result is a creative document where discipline surrenders to the broad subject of “Change.” We hope this magazine serves as an invitation for readers to ask their own questions outside the boundaries of convention. The magazine was printed and distributed for free at our community event (see 3.5) and is freely available online (<https://issuu.com/migrationsmag/docs/finalmigrationszinepages>).

Community Art and Science Day

To fully engage the Santa Barbara community in our unique Thomas Fire experience, we hosted an art and science showcase on UCSB’s campus in June 2018. The all-ages event featured refreshments, a raffle, art sales, and games. This event was intended as a space for the community to view the work accomplished throughout the ACIDD expedition while affording an opportunity

to interact with scientists and ask any questions about the impacts of the Thomas Fire on the ocean (or any questions about the scientific process that they may not have had a platform to ask otherwise). In addition to serving as common ground for community conversations, the space was replete with local artists showcasing their work, including giant images of plankton made with a scanning electron microscope, and a community mural for all guests to contribute to. We also hosted music from local bands, including the band led by the cruise's seagoing musician Hayes, "Walter Etc." The evening concluded with a screening of the Aquatic Cathartic documentary and the free distribution of Migrations magazine.

Lessons learned

Our graduate student science team came away from this experience with many insights. We found it empowering to plan ship time together and to be PIs with the same responsibility our mentors have had in their time at sea. We were acutely aware throughout the experience that we may not be met with the same respect as our mentors—not only were we led by young Chief Scientists still in graduate school, but we also brought aboard a team of artists who carried unconventional equipment and duties at sea. These alternative aspects of our project, however, did not hinder our spirit. We would advise any future graduate student group in a synonymous position to remain confident in their abilities, expertise, and preparation.

One goal of the ACIDD cruise was to learn how the SBC microbiota changed in response to the Thomas Fire, but another goal was to express our process and results to people of varying ages and backgrounds in our community and beyond. Everyone aboard played a different role in accomplishing our goals, and it was important to us that all personnel felt respected and appreciated at sea. Girling designed ACIDD shirts, which were gifted to the crew and team; Jacobs illustrated

208 portraits of the crew, science team, and science itself, which were hung throughout the ship; Baetge
209 and Bisson worked hard to meet the standards of any chief scientist at sea, finding effective ways
210 to facilitate good communication between the science team and ship's crew at all hours of the day.

211 We attribute our scientific successes and our successes of combining art and science to good
212 planning and a diverse, cohesive team. Our approach was to "dream big" and then scale back as
213 we met funding or logistical obstacles. The Thomas Fire presented a great opportunity to test our
214 cruise plan and adaptability. There were disagreements about how to focus our science objectives,
215 which measurements should be given priority, and how the daily plan should be structured. Our
216 early and frequent group meetings solidified our confidence in how we would work well together,
217 ensuring that we would be able to contribute compelling products that would outlast the project's
218 duration. The circumstances surrounding the Thomas Fire were challenging and at times seemed
219 to be insurmountable hurdles, but the team went above and beyond to deal with extra logistical
220 challenges, and opportunistically designed new projects. We feel immensely lucky to have been
221 given charge of a ship. The experience taught us all new things. Even though aspects of scientific
222 research can be solitary, this cruise was a great lesson in the value of teamwork and how to manage
223 and motivate a team successfully.

224 While it would be unrealistic for each oceanography graduate student to plan a major research
225 campaign during their PhD, we have demonstrated that it is not unrealistic for graduate students
226 to collaborate together on projects aside from their dissertations. While some may view side
227 projects as distractions and unnecessary stressors during graduate school, we found that working
228 to create something new together helped to renew our oceanographic inspiration and test our
229 abilities as the next generation of marine scientists. Ultimately, the benefits of pursuing this work
230 have far outweighed the drawbacks.

Working together as artists and scientists through a natural disaster reinforced our sense of responsibility to report our findings to our communities. Capturing the wonder of the ocean and sharing it with friends and strangers alike carries the power to bring together communities and to improve our collective understanding of the ever-changing world in which we live.

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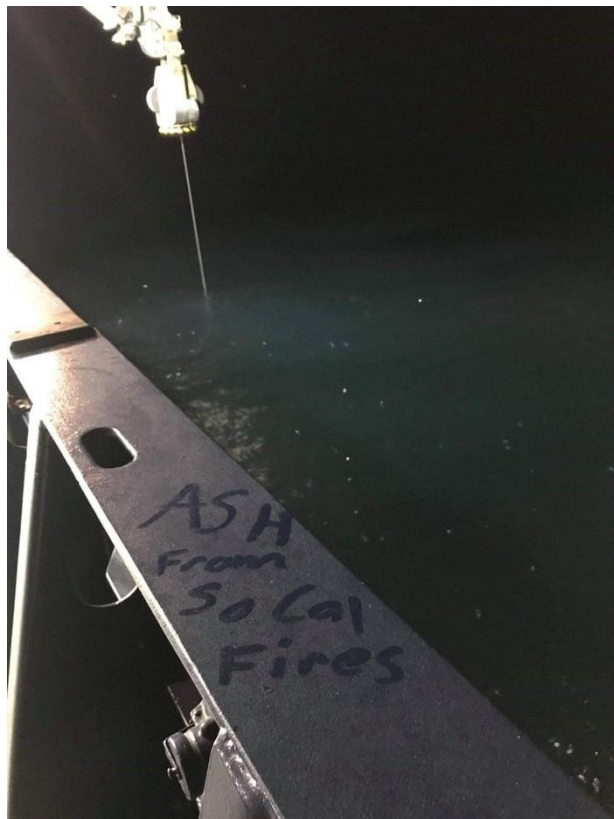
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271 Figure 1. Ash from the Thomas Fire makes a thin layer on R/V Sally Ride. Photo by crewmember
272 Keith Shadle.



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Figure 2. Artist Mariah Reading uses falcon tubes as a canvas to capture R/V Sally ride scene near sunset.

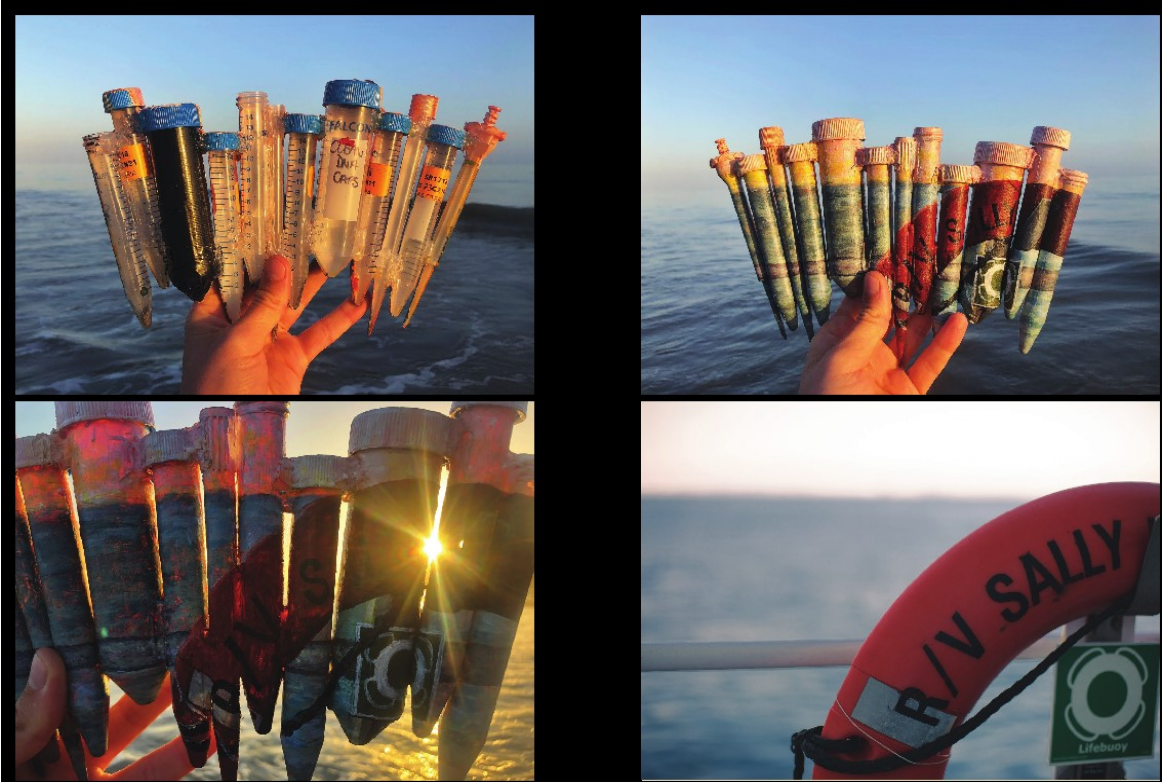


Figure 3. Two pages from the cruise magazine 'Migrations.' Left, UCSB graduate student and ACIDD science team member Aaron Bagnell walks along the starboard side of R/V *Sally Ride* during a CTD cast. Photo by Gad Girling. Right, a poem by Aaron Bagnell entitled 'A Whale.'



A WHALE

AARON BAGNELL

This concrete form, a chapel nave
ribs like arches to suspend

the mortared ceiling of white
barnacle stucco

Its baleen organ blowing
notes to a congregation

singing the Gospel of the Channel
A church that dives, fluke raised

The vanishing steeple