



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Sahand Adibnia	Project Number S0901
Project Title The Effect of Rainfall on the Water Quality of South San Ramon Creek	
<p style="text-align: center;">Abstract</p> <p>Objectives Eutrophication, the excessive richness of nutrients in a body of water, is a growing problem in lakes, rivers, creeks, and coastlines. It is caused by the runoff of nitrates and phosphates, and often leads to algal blooms that create dead zones and produce neurotoxins that can be harmful to humans. Rainfall could potentially cause this runoff, as it may pour agricultural fertilizers from surrounding soils into a body of water. The objective of this project was to determine how the water quality and trophic state of South San Ramon Creek, a creek located in the suburb of Dublin, California, is affected by increases in rainfall.</p> <p>Methods Eight parameters of water quality that indicate trophic state were measured over a two-month period from November 2018 to January 2019. The parameters were dissolved oxygen, temperature, pH, nitrates, nitrites, free and total ammonia, and inorganic phosphates. Ten different measurements of each parameter were taken. Measurements taken within 72 hours before a significant rain (any day with greater than 5 millimeters of rainfall) were part of the control group, and measurements taken within 72 hours after a significant rain were part of the experimental group. Average percent changes between the experimental and control data were calculated, and each parameter was compared with daily rainfall levels on a graph.</p> <p>Results Rainfall caused the creek to stray from its original oligotrophic state to a more eutrophic state. Dissolved oxygen levels decreased by an average of 9.183%. Creek temperatures increased by an average of 36.9%, and correlated with daily median air temperatures. Nitrates increased by 22.6% on average and nitrites increased by 116.74% on average. pH decreased by an average of 2.16%. Free ammonia, total ammonia, and phosphate results were inconclusive.</p> <p>Conclusions Since the creek became more eutrophic, the environment became more suitable for algal blooms. The increase in creek temperatures could have been a result of El Nino and global warming raising air temperatures. Nitrates may have increased due to nitrifying bacteria flourishing at higher temperatures, or from increased agricultural runoff when rainfall levels exceeded 30 millimeters. The massive nitrite increase indicates that industrial runoff occurred as well. In conclusion, the water quality of the creek was impacted by both runoff and weather patterns that were agitated by global warming.</p>	
Summary Statement By measuring eight different parameters of water quality, it was discovered that South San Ramon Creek becomes more eutrophic with an increase in rainfall, indicating that agricultural runoff increased as well.	
Help Received My mother provided transportation to the creek and supervised me while I took measurements. My biology teacher provided me with the Vernier Dissolved Oxygen probe that I used to accurately measure dissolved oxygen.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Sophia Barwegen	Project Number S0902
Project Title The Effect of Light Pollution on Dark Sky Brightness and the Calvin Cycle of Wildflowers in Yosemite National Park	
<p style="text-align: center;">Abstract</p> <p>Objectives This research proposes that if plants from Yosemite National Park experience artificial light pollution, simulated by a 60 watt light bulb underneath a black apron, then those typically found at higher elevations will experience a larger change in CO₂ over a 9 minute period. Additionally, this research also proposes that, if a location in Yosemite is both higher in elevation and farther away from populated areas (ie. Yosemite Valley), then the night sky will experience more brightness.</p> <p>Methods This project was a two-part study: one was a 27-day descriptive study addressing the night sky brightness at different elevations throughout Yosemite, and the second was a study reviewing the effects of light pollution on the Calvin Cycle on plants found in the 5 elevation zones of Yosemite. During the descriptive study, a measurement, magnitudes per square arcseconds, was taken on a Unihedron Sky Quality Meter in order to assess the brightness of the night sky at different elevations in relation to distance from a populated area within the park. The second study took 5 different species of plants (<i>Eschscholzia caespitosa</i>, <i>Helianthus annuus</i>, <i>Eschscholzia californica</i>, <i>Mimulus lewisii</i>, <i>Lupinus albifrons</i>), assessing their growth and CO₂ flux during the Calvin Cycle as they were placed under a black lab apron with a LED lamp underneath to simulate the Calvin Cycle with light pollution.</p> <p>Results It was observed that areas typically above 3,048 meters, or below the Alpine High Sierras, had the lowest amount of sky brightness; also, sites located at least 24.1402 km from Yosemite Valley experienced the greatest dark sky ratings. For the second study, <i>Mimulus lewisii</i>, which is found from 2438.4-3169.92m, had the largest CO₂ change over the course of experimentation, a 9 minute period in comparison to the other wildflowers tested.</p> <p>Conclusions Test sites in Yosemite's backcountry still had high levels of light pollution despite still being defined as protected wilderness areas with the only areas being truly dark were those in the highest elevation zone and at least 24.1402 km from Yosemite Valley. Further, noting that wildflowers' habitats will be a better factor in predicting how light pollution will affect them as <i>Mimulus lewisii</i> faced the greatest CO₂ change despite not being the highest in elevation. These results help quantify the impact of light pollution on plants Calvin Cycles in addition to its effect on dark night skies.</p>	
Summary Statement I tested how artificial light pollution affects the brightness of the night sky in wilderness areas in Yosemite and the Calvin Cycle of wildflowers from the 5 elevation zones of Yosemite.	
Help Received I gained support from my research class teacher, Dr. Koltermann, on how to analyze the results of my Calvin Cycle study on wildflowers.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Amaya Bechler	Project Number S0903
Project Title How Is Bird Abundance and Diversity Affected by Invasive Dense-flowered Cordgrass in Humboldt Bay Marshes?	
<p style="text-align: center;">Abstract</p> <p>Objectives The purpose of this project was to determine differences in bird use between salt marsh dominated by the invasive cordgrass <i>Spartina densiflora</i>, and marshes which have undergone different stages of restoration. This study focused on the low elevation salt marshes of Humboldt Bay.</p> <p>Methods To take data on bird abundance, species, and habitat use, I used point-counts. In the three locations, distinct areas representing each restoration type, I surveyed from two points. I recorded birds for five minutes at each point. The count of each species was recorded in three different categories: on-area, for birds interacting with habitat; off-area, for birds outside of habitat or flying over; and within fifty meters for birds interacting with habitat within fifty meters of the point.</p> <p>Results The average count of birds for the fully restored marsh showed a 54 percent increase over the intermittently restored marsh, and an 86 percent increase over the unrestored marsh. The unrestored marsh had the highest frequency of the guild of seed-eating species, but the lowest counts and frequencies for shorebirds and waterfowl. There was no clear difference in diversity of species between sites.</p> <p>Conclusions The area where <i>Spartina densiflora</i> had been completely removed showed significantly higher numbers of birds, especially shorebirds. This result is supported by another study conducted on the same subject. This is likely due to the decrease in native plant species where <i>Spartina</i> is present, and the adverse effects of <i>Spartina</i> on invertebrate assemblages and marsh physiognomy. These results support the conclusion that removal of <i>Spartina densiflora</i> is essential to maintaining high numbers of waterbirds in Humboldt Bay.</p>	
Summary Statement This study showed how an invasive species of cordgrass affects bird abundance, diversity, and habitat use.	
Help Received I received information about the Humboldt Bay Wildlife Refuge from Brendan Leigh, Andrea Pickart, and Greg Gray, all from the U.S. Fish and Wildlife Service.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Justin Cai; Iris Xia	Project Number S0904
Project Title Implications of Climate Change on Marine Ecosystems: Using Big Data Mining to Analyze Bioturbation and Mass Extinctions	
<p style="text-align: center;">Abstract</p> <p>Objectives Bioturbation, the biogenic mixing of seafloor sediments by marine organisms, is an important ecological process that helps cycle nutrients in the ocean and maintain a functioning ecosystem. Changes in bioturbation illustrate the effects of evolutionary events on marine ecosystems throughout time, which is especially applicable to the modern oceans. Our goal for this project is to generate a complete evolutionary history of bioturbation, especially filling in the prominent literature gap between the Devonian and Triassic Periods. We hypothesize that the extent of bioturbation will generally increase over time, reflecting the increasing biodiversity of marine ecosystems. To test this, we quantified bioturbation using trace fossils, which are fossilized burrows/trackways that preserve the bioturbating behavior of seafloor organisms.</p> <p>Methods We assembled a large trace fossil database, grouping the trace fossil taxons into five reworking modes indicating varying levels of bioturbation. We then used this resource to perform data mining, using a machine reading method to find mentions of trace fossil taxons within GeoDeepDive, a database containing over eight million publications. To handle the large amount of papers, we adapted big data analytics with the Stanford Natural Language Processing tool, which parsed the papers into sentences to identify those containing mentions of trace fossils and their host stratigraphic units. These units could then be matched in the Macrostrat database to place them in chronological order.</p> <p>Results Our results show a rise in the extent of bioturbation, with increases in large-scale sediment mixing and decreases in shallower mixing. Our plots display a clear two-step increase in sediment mixing, exhibiting a pattern that is in line with documented evolutionary radiations. This pattern was likely caused by corresponding increases in oxygen levels and food supply, suggesting that these measures served as limiting thresholds.</p> <p>Conclusions Our plots filled in the literature gap with the two-step increase, improving scientists' understanding of bioturbation over time. The impacts of mass extinctions can also be seen, as the End-Permian extinction marked a pronounced decline in bioturbation. We extrapolate that a man-made mass extinction will cause similar effects, drastically decreasing global bioturbation levels and inhibiting the circulation of oxygen and nutrients.</p>	
Summary Statement Our project involved using a data mining method with natural language processing and the GeoDeepDive platform to determine the prevalence of bioturbation over time, which allows us to see the impact of mass extinctions on marine ecosystems.	
Help Received We completed our project during the summer as part of the Science Internship Program at UC Santa Cruz, so we received help in coming up with the idea from our mentor Professor Matthew Clapham and were able to use some of the equipment in his Paleobiology Lab to aid us in the project.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Trevor Cambron; Natalie Owens	Project Number S0905
Project Title Trails, Soil, and SOD	
<p style="text-align: center;">Abstract</p> <p>Objectives We are studying <i>Phytophthora ramorum</i>, a water mold which is killing tanoaks and causing a foliar infection on Bay laurels in Santa Cruz County. Sudden Oak Death threatens the survival of oaks, an important keystone species, and creates a significant fire danger because of the large amounts of dead trees. The pathogen produces infective spores in wet weather, which are then spread through wind-driven rain, runoff, plant material, and soil. Based on observations from previous tests, we wanted to know if there was a relationship between proximity to trail and infection rate. We hypothesized that the infection rate would be higher closer to the trail and lower deeper in the forest. We also hypothesized that we would find a strong positive correlation between Bay laurel abundance and infection rate and a moderate positive correlation between tanoak abundance and infection rate.</p> <p>Methods To test this, we collected leaves from 25 tanoaks at 5 distances from the trail in 3 plots in the San Lorenzo Valley and cultured them on VARP media for 10 days. We then microscopically identified whether or not each sample was infected with SOD. To look at the density of the forest, we counted the number of tanoaks and Bay laurels within 5 meters of each sampled tree and ran a linear regression relating tree abundance to infection rate. Additionally, we tested the soil along the trails using aqueous leaf baiting and immunostrips.</p> <p>Results We found that the infection rate was higher closer to the trail, and we then performed a T-Test and a Linear Reg T-Test. Based on these tests, we have statistically significant evidence that Sudden Oak Death infections are more common closer to the trail. However, we lack statistically significant evidence of any correlation between Bay laurel or tanoak abundance and infection rate. Also, we were able to detect the pathogen in the soil along the trails.</p> <p>Conclusions Since we found a higher infection rate closer to the trail rather than deeper in the forest, it is possible that the trail itself is a huge factor in how the pathogen spreads. To help combat SOD, we plan on building a boot washing station so that the disease is not transported outside of the forest.</p>	
Summary Statement After culturing and running significance tests, we have statistically significant evidence that Sudden Oak Death infections are more common closer to the trail.	
Help Received Dr. Michael Loik, UCSC answered questions that we had, and Douglas Schmidt and Matteo Garbelotto, UC Berkeley, donated culturing materials.	



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) James Chen	Project Number S0906
Project Title Study of Atmospherically-Relevant Reactions between Dinitrogen Pentoxide with Organic Acids and Chlorine Ions in Water	
Abstract Objectives This project aimed to explain why the presence of organic acids is able to suppress the reaction between dinitrogen pentoxide and chlorine ions. It was hypothesized that formate ions, which were used to model organic acids, are more likely to react with dinitrogen pentoxide than chloride ions, because the reaction with formate ions requires less activation energy to occur. Methods The reactions between dinitrogen pentoxide and either formate ions or chlorine ions were studied in three different trials, with the presence of either zero, one, or six water molecules. This project used the quantum chemistry programs QChem and GAMESS in conjunction with a supercomputer at UC Irvine. The programs were used to optimize molecular structures, calculate potential energies, search for transition states, and more. For each trial, various reaction pathways were proposed and analyzed in the search for the most favorable reaction pathway. Thermodynamic calculations were then performed to calculate the activation energy. Results With zero and one water molecule, both formate ions and chlorine ions react spontaneously with dinitrogen pentoxide. In the presence of six water molecules, a full reaction pathway was found for both formate ions and chlorine ions. Thermodynamic calculations showed that the activation energies for the reaction between either formate or chlorine and dinitrogen pentoxide were 2.3 kcal/mol and 3.7 kcal/mol respectively. Conclusions The hypothesis was supported by the data, as the activation energy for the reaction with chlorine ions was 61% higher. This project can be applied to other organic acids, as the formate ion represents the carboxyl group common on organic acids. The reaction between dinitrogen pentoxide and chloride ions contributes to ozone destruction, but the work done in this project can be used to find possible solutions.	
Summary Statement In this project, computational methods were used to explain why the presence of organic acids suppresses the reaction between dinitrogen pentoxide and chlorine in water.	
Help Received This project was conducted in the Gerber Lab at UC Irvine, and my mentors were Professor R. Benny Gerber and Dr. Natalia Karimova, a postdoctoral student. My mentors taught me how to use the programs, introduced me to the tools at my disposal, discussed my project with me, and helped with troubleshooting.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Mariah Cox	Project Number S0907
Project Title The Effects of Wildfire Ash on Soil Nutrient Levels	
<p style="text-align: center;">Abstract</p> <p>Objectives There have been multiple wildfires around the state of California in the past few years. I wanted to see if the ash from the wildfires affect the nutrient and pH levels of the soil, making it easier for plants to grow back.</p> <p>Methods I gathered the branches and duff layer from where I collected my dirt to simulate a wildfire and to collect the ash. I had two containers without an ash layer for controls and four containers with an ash layer for testing samples. I watered once every 12 hours for 24 hours with 4 gallons of water for each sample each time. I obtained a core sample from the middle of each container and tested each one three different times with a Rapitest soil test kit. I tested it for nitrogen, phosphorus, potassium, and pH. I then sent each soil sample off to A and L Laboratories in Modesto, CA for more accurate testing.</p> <p>Results The results from the Rapitest soil test kit and A and L Laboratories were very similar, but A and L had much more detail with numbers instead of colors. The nitrogen in my controls was very low at 1 ppm and the samples with the ash were all 1 ppm except for Sample 2 which was 4 ppm. The phosphorus in my controls was 10.5 ppm and in the samples with the ash were averaged to 28.75 ppm. The potassium in my controls was very low at 167.5 ppm and the samples with the ash were 288.75 ppm. The pH of the controls were 6 and in the samples with the ash my pH was between 6.5 and 7.1. Samples 1 and 3 are similar and samples 2 and 4 are similar except there is a significant difference between the two groups. I found part of an owl pellet in Sample 4 and I think the rest of it may have been in Sample 2 making these two samples outliers.</p> <p>Conclusions After using the Rapitest soil test kits and getting the results back from A and L Laboratories, I found that the ash did indeed add nutrients back into the soil and made the pH more neutral because the soil was acidic before adding the ash.</p>	
Summary Statement After the recent wildfires we have had the past few years in California, I decided to test nutrient and pH levels of the soil to see if wildfire ash affects it in a positive or negative way.	
Help Received	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Heather Galinato	Project Number S0908
Project Title Tsunami Simulation: Slope vs. Inland Travel	
<p style="text-align: center;">Abstract</p> <p>Objectives The objective of this project was to investigate the relationship between the slope of the seafloor and the inland travel of a simulated tsunami.</p> <p>Methods Used three identical wooden bins, holding salt and flour dough models with varying slopes. Lifted water-filled bins from one end (bins were slanted) and dropped them from various heights. The inland travel of the water was measured in cm.</p> <p>Results During the 10 and 20 cm lift tests, the water traveled further on the steeper sloped model. During the 15 cm lift test, the water traveled further on the more gradually sloped model. Overall, the water on the sloped models traveled noticeably less than the water on the control model.</p> <p>Conclusions It was concluded that steeper slopes of the seafloor slightly increase the inland travel of water when compared with gradual slopes. While conducting the experiment, an indentation in the 20° sloped model was noticed. This indentation allowed water to travel further on this model for the 15 cm test. It is speculated that for the 10 cm test, there was not enough force to allow the water to fully benefit from this indentation. For the 20 cm test, it is speculated that the ease for water travel allowed with the indentation was overridden by the energy of the water on the steeper sloped model.</p>	
Summary Statement Through a tsunami simulation, I found that a steeper slope allows for slightly further inland travel.	
Help Received I designed and built the bins and the dough models. My siblings helped me lift the bins during testing. My Biology teacher helped revise my writing.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Vivian Gerstein	Project Number S0909
Project Title The Effect of Wildfire Smoke on Fermented Grape Products	
<p style="text-align: center;">Abstract</p> <p>Objectives The purpose of this experiment was to determine 1) if wildfire smoke affected grapes grown in Lake County and 2) if this smoke affected people s opinions of fermented grape products (single fermentation wine and vinegar) made from grapes grown in a range of wildfire smoke exposures. I hypothesized that as exposure to wildfire smoke increased, samplers ability to detect smoke taint would increase in both wine and vinegar made from wildfire smoke exposed grapes.</p> <p>Methods Five different samples of Cabernet Sauvignon wine grapes from Lake County were collected, all from varying exposures to wildfire smoke generated during the 2018 Mendocino Complex Fire. The crushed grapes and their juice were processed through a single fermentation, then split into two groups. One juice group s fermentation was ended and called a single fermentation wine and the other was fermented into vinegar. Adult samplers tasted and smelled each wine or vinegar sample and were asked to rank them in order of most to least similar to the control (i.e. the sample that contained no smoke). Their rankings were compared to the chemical analysis of the Lake County wine grapes that documented the presence of common compounds associated with wildfire smoke (e.g. the volatile phenols guaiacol and 4-methylguaiacol released from the combustion of woody plants).</p> <p>Results In general, the samplers were able to detect the difference between the control and tainted samples, but for the tainted samples, they were not able to tell relative smoke exposure levels. Single fermentation wine and vinegar sample results followed this same pattern.</p> <p>Conclusions With the increase in fire severity in California, fire and smoke damage are becoming more common. The drier conditions and longer fire season associated with climate change may increase the number of wildfires and thus exacerbate the situation. My results partially supported my hypothesis. All samplers were able to differentiate smoke tainted fermented grape products from control (non-exposed) grape products; however, only some samplers were able rank the level of smoke exposure relative to the control. California s grape growers will continue to have the long-term challenge of growing grapes in fire-prone areas and the strong possibility of wildfire smoke interactions.</p>	
Summary Statement I determined that wildfire smoke affects grapes and their fermented products, though the detection of this taint is not uniform.	
Help Received I received guidance from Glenn McGourty, UC Cooperative Extension viticulture advisor in Lake County.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Dillon Gonzalez	Project Number S0910
Project Title The Effect of Rheology on Reverse Faults Using a Fault Deformation Machine.	
<p style="text-align: center;">Abstract</p> <p>Objectives The purpose of this experiment is to prove that smaller sized particles will take longer to fault than larger sized particles in reverse faulting. It was hypothesized that if smaller sized particles have a greater surface contact area, then an increased friction will allow the particles smaller in size to be more rigid than those larger in size, resulting in the smaller particles requiring more time to fault.</p> <p>Methods Constructed and used a fault deformation machine to subject materials with varying particle sizes (clay, sand, and gravel) to compressional forces to model the formation of reverse faults. By measuring the amount of force required for a material to fault, the amount of faults produced in a material, and the length of the faults in a material, it can be determined which material is the strongest and therefore the most resistant to reverse faulting.</p> <p>Results After testing each of the three materials ten times, the results show that clay took longer to fault than both gravel and sand, and sand took longer to fault than gravel. Clay also had the lowest average number of faults, and sand had the second lowest number of faults, leaving gravel with the highest average of faults present. Due to clay's absence of faults, it had the shortest average length of faults, followed by gravel with the second lowest average length of faults, and sand having the highest length of faults on average.</p> <p>Conclusions After subjecting each material used to compressional force ten times each, it can be concluded that smaller sized particles take a greater amount of time to fault than larger sized particles due to the frictional forces experienced between the differently sized particles. This is due to the smaller sized particles having a high degree of friction because of the increased surface contact area between the individual particles. Contrarily, particles larger in size have less surface contact area in comparison to their overall size leading to less friction. This results in the smaller sized particles having a higher rigidity than those larger in size. Because of this, more compressional force, represented by turns of the crank, is required in order to overcome the strength of the material. Consequently, the larger sized particles will take less time to fault due to the weaker rigidity that they have.</p>	
Summary Statement A fault deformation machine was used to subject materials with varying particle sizes to compressional forces to model the formation of reverse faults.	
Help Received I received help and guidance on the formulation and execution of a project from Dr. Heather Ford and graduate student Gillian Goldhagen from the University of California Riverside's Department of Earth Sciences.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Ruby Howard; Katherine McCormick; Helen Leslie Schafer-Dews	Project Number S0911
Project Title Soil Water Content Relative to French Broom Removal in the San Lorenzo Valley Watershed	
<p style="text-align: center;">Abstract</p> <p>Objectives Our goal is to better understand the unique ecosystem that is the Santa Cruz sandhills and how they are impacted by invasive species. We hypothesize that there will be more soil water in areas where French broom has been removed.</p> <p>Methods We compared soil moisture in three treatments: French broom standing, French broom removed, and no French broom invasion. Each treatment contained two to three soil moisture sensors. We used data loggers to record the soil moisture sensor signals. We made custom rain gauges to measure rainfall both under the cover of the trees and in the open to determine throughfall. We also compared soil texture (% sand, silt, and clay) to determine whether it could have affected soil water content. Results: Our data show that the treatments with French broom removed had the highest soil water content, intact French broom had the second highest, and finally, the area where French broom never lived had the least moisture in the soil.</p> <p>Results Our results showed that the areas with broom removed had the highest soil moisture content, then the areas with broom, and finally the areas where broom was never present. This leads to the conclusion French broom has a large effect on the moisture reaching other species in the sandhills. Since French broom is an invasive species the removal of broom, that was tested as one of our treatments, will benefit the ecosystem in the sandhills by providing more soil moisture.</p>	
Summary Statement We tested the soil moisture for three different treatments relative to the growth of French broom in the Santa Cruz sandhills.	
Help Received Micheal Loik was instrumental in helping us resource and implement our sensors as well as recording and analyzing the data.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Brian Ith; Marcus Rodriguez	Project Number S0912
Project Title Examining Invasive Boars' Impact on Water Quality in Tejon Ranch Conservancy in Comparison to Wind Wolves Preserve	
<p style="text-align: center;">Abstract</p> <p>Objectives Examine and deduce a connection between poor water quality in natural parks and the presence of wild boars by analyzing a park with boars living in it to a park without boars.</p> <p>Methods Used camera traps given from Tejon Ranch to examine spots where pigs reside. Then take water samples from these locations, while taking water samples from Wind Wolves Preserve (a park without boars). Then compare the water quality between the two parks by examining pH, nitrate, and conductivity.</p> <p>Results The pH, nitrate, and conductivity found in Tejon Ranch (the boar park) depicted unhealthy levels of water in the park where the boars reside. While Wind Wolves Preserve, which has no boars, showed optimal levels of water.</p> <p>Conclusions The non-native species to Tejon Ranch Conservancy, Wild Boar, has caused major damages to the habitats, biodiversity, and overall health. Their population needs to be reduced to moderate numbers to prevent the contamination of the water. Also, if pig populations are controlled, then species would not have their habitat destroyed and the diversity of wildlife would be at a balance once again.</p>	
Summary Statement We examined water quality in natural parks and examined a connection to where the wild boars lived and poor water quality.	
Help Received Mike Brasier, our teacher and advisor. Ranger Brooke from Wind Wolves Preserve for showing us water areas. Rangers from Tejon ranch for supplying camera footage and water.	



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) Mateo Jimenez; Marcos Lucero	Project Number S0913
Project Title Comprehension of Slope Stability with an AR Sandbox	
<p style="text-align: center;">Abstract</p> <p>Objectives Construct an Augmented Reality Sandbox to understand landslides/ find the most efficient method in preventing landslides</p> <p>Methods Manipulating the sand in the box to varying degrees of slope and simulating rainfall to create simulated landslides/ Laptop computer running Linux software programmed to display a real-time topographic map from a projector and xbox kinect sensor on top of the sand in the box</p>	
Summary Statement We constructed an AR Sandbox to further understand the physics of landslides	
Help Received We received help from our environmental science teacher, physics teacher, a parent, and a brother.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Patrick Kim	Project Number S0914
Project Title Developing Coupled Physical-Biogeochemical Models of Mesozooplankton Dynamics in the California Current System	
<p style="text-align: center;">Abstract</p> <p>Objectives Mesozooplankton play an important role in the global ocean. They are intricately intertwined in the pelagic food web and are major contributors to biogeochemical element cycling through vertical migration. However, much is unknown about the quantitative distribution and biomass of mesozooplankton in the ocean. Our limited knowledge of mesozooplankton dynamics impairs the development of ecological models, which are used to understand interactions of marine resources with functioning of the earth. In the upwelling system of the California Current System (CCS) and other productive regions throughout the ocean, these models are integral in developing sustainable environmental policy. In this study, I aim to assess ecological dynamics of mesozooplankton in the CCS and analyze the accuracy of current simulative models of these dynamics.</p> <p>Methods Standardized and synthesized datasets accessed from MARine Ecosystem DATa (MAREDAT), a global database of zooplankton pigments, and the World Ocean Atlas, a database of observed ocean statistics. Extracted climatological fluctuations of mesozooplankton biomass, sea surface temperature, chlorophyll levels, salinity, and photosynthetically active radiation in the CCS. Compared observational analyses with model output from a coupling of the Regional Ocean Modeling System (ROMS), modeling ocean physics, and Biogeochemical Elemental Cycling (BEC), modeling biogeochemical dynamics. Evaluated model accuracy through spatial, seasonal, and yearly scales.</p> <p>Results Observational climatologies of mesozooplankton biomass and oceanic stressors verified the significance of upwelling dynamics in the CCS. Model outputs underestimated mesozooplankton biomass during upwelling seasons and in regions of coastal upwelling. Regions of overestimation aligned with oligotrophic offshore regions.</p> <p>Conclusions Current simulative models misrepresent mesozooplankton dynamics in the CCS. Compartmental modifications of models that consider diversity and variation in mesozooplankton may yield more accurate estimations of mesozooplankton dynamics. With increasing perils of anthropogenic climate change, accurate reforms of simulative models reflecting observed biological dynamics are essential for future development of sustainable fishery management, regulation of wastewater nutrient outfall, and robust climate policy.</p>	
Summary Statement I find that current models of mesozooplankton dynamics underestimate impacts of upwelling in the California Current System and suggest compartmental reformation of simulations that may yield more accurate representations of these dynamics.	
Help Received I received guidance from Jérôme Guiet, Ph.D., and Professor Daniele Bianchi of the UCLA Department of Atmospheric and Oceanic Sciences in narrowing my research questions and analyzing datasets through MATLAB.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Yoonji Kwon	Project Number S0915
Project Title No Smoke Without Fire: The Impact of Wildfires on Exposure to Particulate Pollutants	
<p style="text-align: center;">Abstract</p> <p>Objectives To evaluate exposure to particulate pollutants from wildfire smoke, PM_{2.5}, PM₁, and black carbon (BC) concentrations were monitored during wildfires and after extinguishment. The infiltration of wildfire smoke pollution from ambient to indoor air was determined by concurrent measurement inside and outside a home. The composition of pollution and the impacts of meteorological conditions on exposure were also examined.</p> <p>Methods For PM measurements, DustTrak DRXII monitors (TSI Inc.) were used, and for BC, MicroAeth AE51 monitors (AethLab) were used. Monitors were programmed for 1 minute log intervals. Hourly and daily averages were found from the 1 minute average data. During the monitoring periods (first from July 29-Aug. 19, then from Nov. 16-23), PM_{2.5} levels were monitored by Real-time Air Advisory Network (RAAN) data from the Fresno and Clovis sites. Information on wildfires for the monitoring periods was obtained from the San Joaquin Valley Air Pollution Control District. Meteorological data was retrieved from the Fresno Yosemite Airport weather station.</p> <p>Results The average infiltration factor (IF) for the pollutants was about 28% in July-August and 36% in November. IFs for all pollutants were slightly greater during wildfires than after extinguishment in both monitoring periods. Indoor concentrations were consistently lower than outdoors. Average concentrations for all pollutants, in ambient and indoor air, were about 3-6.5 times greater during wildfires than after extinguishment. Standard deviations of all pollutant concentrations, indoors and outdoors, were significantly high during wildfires, showing high variability in exposure during wildfires. BC constituted <5% of PM_{2.5} and PM₁ during wildfires and after extinguishment. PM₁ constituted about 98% of PM_{2.5} concentrations.</p> <p>Conclusions Wildfires significantly elevate pollutant concentrations and thus, exposure and health risks. The IF is a specific characteristic of a building and seasonal activity because IFs did not significantly increase during wildfires and remained consistent for each monitoring period. Results suggest that strong gust wind and precipitation drastically decrease pollution and are a major factor in high variability in exposure. BC is a consistent component of PM. Much of the PM emitted during wildfires is PM₁, implying further human health effects.</p>	
Summary Statement Wildfires significantly increase exposure to the particulate pollutants of PM _{2.5} , PM ₁ , and BC without significantly changing the infiltration of pollutants and cause high PM ₁ content in exposure; exposure to particulates from wildfires can	
Help Received I received help from a professor at the University of the State of California, Fresno. He helped me gain access to and learn how to use the air pollution monitors in my project.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Tessa Marks; Mackenzie Swenson-Thole	Project Number S0916
Project Title An Analysis of the Relationship between Climate Change and Lyme Disease	
<p style="text-align: center;">Abstract</p> <p>Objectives The objective of this study is to demonstrate the connections between climate change and Lyme disease.</p> <p>Methods Using online databases, such as data from NASA, NOAA, the National Weather Service, and CDC, we compiled information regarding Lyme disease cases, temperature, etc. This data was used to do a comparative analysis.</p> <p>Results Although a general trend was shown when comparing cases and temperature anomaly, no clear connection was demonstrated when studying temperature, further research into factors such as humidity and precipitation is necessary to create a predictive model.</p> <p>Conclusions Further studies would allow us to estimate the number of cases of Lyme disease that would be expected if the change in climate stays on the same trend and if nothing is done to prevent the number of infections from going up.</p>	
Summary Statement We demonstrated the relation between climate change and the rise in cases of Lyme disease.	
Help Received All data was taken from online resources that are publicly available. Besides small amount of advice from our science teacher, our project was done independently at home.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Ellery McQuilkin	Project Number S0917
Project Title Sierra Streams: The Effect of Glacial Melt on Fall Flow	
<p style="text-align: center;">Abstract</p> <p>Objectives I was curious to see if watersheds with melting glaciers would have a greater early fall streamflow than watersheds without glaciers.</p> <p>Methods I selected study areas in Glacier Creek, Virginia Creek, and Walker Creek watersheds in the Sierra Nevada mountains, ranging from 3000m to 4000m in elevation. Dana Glacier contributes to flow in Glacier Creek because it is melting, having lost 85% of its volume since 1883. My other two watersheds did not have glaciers. I spent over 20 hours learning to use GIS, a complex geographical analysis program, to analyze area and elevation to select watersheds with similar profiles. I measured streamflow in September after the winter snowpack had melted. I hiked 2-9 miles to each site and used the salt conductivity method to measure streamflow. This method is generally used in small turbulent alpine creeks without a consistent cross-sectional area. To determine streamflow, I poured a known amount of saltwater into my stream and measured the change in conductivity over time. I then performed a controlled calibration experiment to find the relationship between dilution and conductivity. With all of my data from the field I created an analysis spreadsheet and used a complex mathematical equation to calculate streamflow.</p> <p>Results I found that Glacier Creek had the largest streamflow of 2.7 cubic feet per second (cfs), Walker Creek had a streamflow of 0.2 cfs, and Virginia Creek had a streamflow of 0.7 cfs. Glacier Creek was 10.7 times larger than Walker Creek, and 3.5 times larger than Virginia Creek. I normalized my results and Virginia and Walker Creek's streamflow only changed by 0.04 cfs or less. These results are consistent with my observations in the field.</p> <p>Conclusions Dana Glacier melt was the only significantly different contributor to streamflow in my watersheds and is the cause of higher flow in Glacier Creek. This indicates that my hypothesis was correct. Glaciers all across the world are melting away, which will have significant effects on the plants and animals that depend on the environments glacial melt streams currently support. Streamflow will significantly reduce in early fall, so people need to begin adapting cities and agriculture for a drastically different future. Due to climate change it is too late to save glaciers but if we take immediate action to curb our carbon emissions, we can preserve much of the wintertime snowpack.</p>	
Summary Statement I measured streamflow in three similar high altitude Sierra watersheds using the salt dilution method and found that one watershed had a significantly larger early fall streamflow due to glacial melt.	
Help Received Thank you to Dr. Connie Millar for being my science advisor. Thanks to Dr. Greg Stock who helped me with the procedure for the salt dilution method. Also to Maureen McGlinchey for helping me learn and use GIS. Thanks to Geoff McQuilkin (my dad) for help in the field and with data analysis.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Tai Michaels	Project Number S0918
Project Title Streamflow Measurement and Prediction in Southern California: An Observational and Citizen Science Project	
<p style="text-align: center;">Abstract</p> <p>Objectives As Southern California faces an increasing threat of drought in our warming climate, it is crucial to understand streamflow patterns to optimize our usage of this essential resource. In order to analyze streamflow patterns, this study analyzed manual measurements of streamflow presence or absence in headwater streams to minimize anthropogenic influences present in other measurement methods. Data were collected both by the study throughout streams surrounding the LA Basin and by a citizen science project nationwide. Regression analysis of the data revealed that Southern Californian streams have greater overall seasonal variation as compared to the national average. In addition, they are far drier in their driest months and wetter in their wettest months indicating both a more rapid response to precipitation and a more rapid decline as precipitation decreases. Thus, this study has applications both as a study through differentiating national and local streamflow patterns and as a proof of concept for the use of citizen science observations to improve streamflow modeling. Improved models is crucial in water resource management, drought prediction, and flood modeling, and this study is a step towards a novel approach to this critical issue.</p> <p>Methods</p> <ul style="list-style-type: none">An immunity to poison oak35m climbing ropeCompassTopographic mapsGPS <p>Stream Observations Over the course of four years, more than 200 streams around the Los Angeles Basin (primarily Santa Monica and San Gabriel Mountains) were surveyed for streamflow presence and absence. Streams and time of visit were selected at semirandom locations and dates subject to some inherent bias. Data were aggregated and only sites with three or more observations were used in the analysis.</p> <p>StreamTracker Data Obtained data from StreamTracker a citizen science project which compiles observations of small stream streamflow from across the nation. Data were aggregated and only sites with three or more observations were used in the analysis.</p>	
Summary Statement In analyzing streamflow patterns, a novel citizen science observation method was used to enhance the accuracy of the model.	
Help Received None	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Gavin Peters	Project Number S0919
Project Title Phytoplankton Assemblage Composition at White Point Hydrothermal Vent	
<p style="text-align: center;">Abstract</p> <p>Objectives It is the primary objective of this research to develop a better understanding of the ecophysiological conditions leading to toxic algal blooms. Through water analysis and phytoplankton composition comparisons from three locations in the shallow waters off White Point, CA, this project was designed to discover if nutrients from vent effluence, specifically nitrates and phosphates, as well as increased temperature contributions would create an ideal environment for harmful phytoplankton to proliferate. The hypothesis was a unique signature of phytoplankton would be present in association with an active hydrothermal vent site.</p> <p>Methods The California Department of Public Health (CDPH) Marine Biotxin Monitoring Program supplies volunteers with a 20 µm mesh phytoplankton net, data spread sheets, and microscope observation protocols. Using an OMAX digital compound LED microscope, plankton samples were averaged to obtain an accurate representation of relative abundance for each organism observed. The tallied data and water samples were sent to Richmond, California for verification by CDPH Environmental Management Branch experts. Twelve samples were examined during a week in November and abundance compositions were compared between three locations.</p> <p>Results Patterns were highlighted using data spreadsheets to uncover which organisms were prevalent at each sample location at White Point Beach. The Cyanobacteria produced in association with the active hydrothermal vent site were over three times greater than the other two locations. Navicula, Cylindrotheca, and Licmophora were also observed consistently across samples taken above the hydrothermal vent.</p> <p>Conclusions The hypothesis that a unique signature of phytoplankton could be found associated with an active hydrothermal vent site was supported by the results. This indicates the importance for further research to address the knowledge gap among toxin-producing phytoplankton in connection to its ecophysiological niche.</p>	
Summary Statement I investigated a novel association between the organisms that cause harmful algal blooms and hydrothermal vents.	
Help Received Dr. Elizabeth Trembath-Reichert, at Woods Hole Oceanographic Institution, suggested that I investigate the hydrothermal vents at White Point. My project design was reviewed by Carl Carranza at the Cabrillo Marine Aquarium.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Mia Placencia	Project Number S0920
Project Title A Study of Particulates Emitted from Printers	
<p style="text-align: center;">Abstract</p> <p>Objectives The objective was to test if office and home printers released particulate matter during printing and assess if the level of particulates was unhealthy.</p> <p>Methods Identified the printer model, switched printer paper to Hammermill Printer Paper, downloaded document to print from a USB Flash Drive, recorded particulate levels using Dylos DC1700 Air Quality Monitor for one minute before printing(control), 20 seconds during printing, one minute after printing, and entered data to Microsoft Excel.</p> <p>Results 52 printers were tested and examined. A chi square test was used and produced a confidence level of over 99.99% for both large and small particles. The printers all gave out substantial amounts of particulates and the change in air quality was due to the printers.</p> <p>Conclusions Each printer was recorded and analyzed. The chi square tests suggest that printers caused a change in the air quality. The data suggest that the year of the printer was of no relevance. The most emitting model types for both large and small particulates were HP LaserJet 600 M602 and HP Color Laser Jet 3600n. Printers can release unhealthy levels of particulates and the information could be used for awareness, manufacturing processes, and regulations.</p>	
Summary Statement I measured particulates that printers emitted during printing to see if the levels were unhealthy. The printers released a substantial amount of particulates during the process of printing.	
Help Received I conducted the experiment on my own. I received help from my mentor Riccardo Magni with learning some methods of analysis and provided me with the monitor/equipment. I also received help doing research of printer years by my other mentor/assistant Ramon Morales.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Ashwin Sivakumar	Project Number S0921
Project Title Studying Avian Biodiversity Changes after Wetland Restoration: A Novel Approach via Remote Sensing and Citizen Science	
<p style="text-align: center;">Abstract</p> <p>Objectives Wetlands, extremely important as wildlife habitats, are under severe threat in the United States. Preservation and restoration of wetland habitats is therefore critical for improving the health and diversity of wildlife populations. This study aimed to assess the effectiveness of a wetland restoration project at Fernhill Wetlands, Oregon by developing a low-cost, novel, and reusable technique combining remote sensing satellite imagery and geospatial climate data and performing quantitative correlations to citizen science bird observations from Cornell University's eBird database.</p> <p>Methods 254 LANDSAT-8 and 230 SENTINEL-2 satellite images and PRISM climate datasets from 2013-2018 were imported and processed in the cloud using Google Earth Engine. From these data, quantitative indices for vegetation, water area, and climate were calculated for the pre- and post-restoration periods. Quantitative correlations were then established in R between these indices and 146,457 observations in the eBird observation dataset. Finally, supervised classification was used to obtain clarity on land, vegetation, and water changes at Fernhill.</p> <p>Results Several terrestrial species and deep-water diving ducks correlated well with vegetation and water indices, as expected. Shorebirds, marsh birds and other species at the water's edge showed subtler and sometimes unexpected reactions to habitat change, effects that were not visible with conventional analyses. Particularly notable were the dabbling ducks that showed no correlation to the expected indices, and this was later shown to be due to compensating effects from different species within the group that reacted differently to the habitat change.</p> <p>Conclusions The new technique showed that the habitat restoration had a positive impact on several species as hypothesized. It was also effective in highlighting unexpected signals and relationships not obvious in previous studies, prompting further analysis. The results also implied that subtle feeding or other behavioral differences among species, even within the same category, could significantly influence their response to habitat change. This technique is low in cost due to the use of free, publicly available datasets and cloud computing resources and has drawn interest from ecologists. The methodology is reusable and allows for powerful and effective ongoing monitoring of wetland habitats.</p>	
Summary Statement I developed a low-cost, novel, and reusable methodology combining LANDSAT, SENTINEL, PRISM, and eBird datasets for the first time to do a quantitative study of the effect of wetland habitat restoration on the biodiversity of avian fauna.	
Help Received I got advice on publicly-available satellite data options from Mr. Benjamin Holt of NASA JPL. I got background information on Fernhill Wetlands and information on a prior study conducted at the site from Mr. Jared Kinnear of Clean Water Services and Mr. Joe Liebezeit of Portland Audubon.	



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Brayden Stark	Project Number S0922
Project Title A Systematic Method to Reduce the Biomass of a Harmful Algal Bloom (HAB)	
<p style="text-align: center;">Abstract</p> <p>Objectives The purpose of my research is to examine methods to economically and safely reduce the density of cyanobacteria within mimicked oceanic Harmful Algal Blooms. Once the cyanobacteria cell colonies become visible the next step is to identify the most effective method to inhibit nitrogen-fixation in order to reduce the biomass of the cyanobacteria bloom.</p> <p>Methods The cyanobacteria strains of Gloeocapsa, Gloeotrichia, Nostoc, Oscillatoria, and Anabaena were acquired from Ward s Science. Bold s Basal Medium was prepared through six stock salt solutions of NaNO₂, MgSO₄X7H₂O, K₂HPO₄, KH₂PO₄, CaCl₂, and NaCl. Allens Blue-Green Medium was created and consisted of 1.59g of NaNO₃, .039g of K₂HPO₄, .075 MgSo₄, .02g Na₂Co₃, .058g NaSio₃, .001g EDTA, and .006g citric acid. A solidified modification of Bold s Basal Medium was purchased from Phytotech Labs and 50g was mixed with 40 mL of distilled water and 1 mL of 1% Sulfuric Acid. The solidified Bold s Basal Medium had a pH of 2.98 and was adjusted to 6.68 pH using a 6 molar concentration of sodium hydroxide and hydrochloric acid.</p> <p>Results The three mediums were compared to determine the optimal pH, salinity, temperature, and lighting environment to mimic an oceanic Harmful Algal Bloom. 2 mL of solidified Bold s Basal Medium was added to 10 mL of Oscillatoria and 10 mL of Anabaena, which proved to be the optimal growth medium. Samples were placed in indirect sunlight at 22 degrees Celsius and were adjusted to 6.68 pH. The growth of the cyanobacteria was measured every day for two weeks using a spectrophotometer, and the results indicate that transparency decreased and absorption rates increased for all samples during the testing period. Measurements were taken at 400 nm and 750 nm to ensure that data was consistent along various wavelengths of the light spectrum.</p> <p>Conclusions Through various trials and experiments I was able to start the process of determining the optimal conditions for rapid cyanobacteria growth within a controlled environment. The addition of 2 mL of Bold s Basal Medium and adjusted pH of 6.68 will allow for optimal growth conditions of Anabaena. Additionally, indirect sunlight and a temperature of 22 degrees Celsius have yielded the best results. This means that that rapid growth of cyanobacteria can occur within the test tubes and form visible cell colonies, thus mimicking an oceanic Harmful Algal Bloom.</p>	
Summary Statement I am in the process of mimicking a Harmful Algal Bloom to study methods to systematically reduce the biomass of cyanobacteria within a bloom.	
Help Received I designed the experiments myself after reading scientific journal articles about growth of cyanobacteria. My project advisor and former Biology teacher Dr. Gonzalez supervised me while I created the culture mediums.	



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY**

Name(s) Joyce Sung	Project Number S0923
Project Title Earth Has a High Fever That Makes It Sour: The Impact of Global Warming on the Concentration of Carbon Dioxide Produced	
<p style="text-align: center;">Abstract</p> <p>Objectives The objective of this study is to explore the relationship of different salinities on earth that contain different levels of carbon dioxide in the ocean due to global warming.</p> <p>Methods Made 0.05M of NaOH that is standardized with KHP. Produced carbon dioxide through a soda machine for each salt concentration. Flattened each carbonated solution for 2 minutes then added 3 drops of phenolphthalein, which is used to titrate to find the molarity of carbon dioxide.</p> <p>Results As the concentration of saltwater increases, the molarity of carbon dioxide decreases and as the concentration of saltwater decreases, the molarity of carbon dioxide increases.</p> <p>Conclusions With a lower concentration of sodium chloride, the ocean absorbs a higher concentration of carbon dioxide, which produced more carbonic acid that lowers the pH level. Higher temperature of the ocean tend to have higher salinity rates and it also increases the density of salt water, whereas the pH level will increase as well.</p>	
Summary Statement I found the relationship where global warming correlates with different levels of salinity and concentrations of carbon dioxide produced in the ocean; as the concentration of saltwater decreases, the molarity of carbon dioxide increases.	
Help Received I conducted the the experiment alone. My science teacher via school provided the chemicals and materials, as well as confirmation of my results.	