Acute myeloid leukemia (AML) is a life-threatening cancer characterized by an over-proliferation of myeloid cells in the blood. Despite advances in treatment of AML, relapse and treatment resistance continues to be an issue for people afflicted with myeloid leukemia. This indicates that the molecular mechanisms involved in the development and progression of myeloid leukemia are not fully understood. Receptor tyrosine kinases (RTKs) are membrane-bound proteins involved in cell migration, growth, and proliferation. Dysregulation of RTKs has been identified in myeloproliferative disorders. Involved in this signaling pathway is growth receptor-bound protein 2 (GRB2), an accessory signaling protein that binds to FGFR2 intracellularly. GRB2/FGFR2 binding is an important step in FGFR2 phosphorylation, downstream signaling, and subsequent cell proliferation. Our data indicates that there is a dysregulation of GRB2 levels in murine (MEL) and human (K562) leukemic cell lines. Given that FGFR2 dysregulation has been identified in human cancer and GRB2 is instrumental in pathological signaling downstream of FGFR2, we hypothesize that GRB2 dysregulation is involved in AML. Our future studies are now focused on designed GRB2-overexpressing transgenic zebrafish and testing novel synthetic compounds that alleviate aberrant GRB2 signaling. This research will expand the existing knowledge of acute myeloid leukemia, provide novel models of zebrafish leukemia and open up new areas for targeted drug therapies.
Recipients of the Tom Rodgers Outstanding Researcher Award

Department of Biological Sciences
California State University, Chico

1997 Ronald E. Loggins
1998 Maura Eagan
1999 Moaiad A. Kanaan
2000 Carina M. Jung
2001 Cary Coburn
2003 Glen Lubke, Jack Campbell, Gary Lechner
2003 Julia Terry
2004 Colleen Martin, Michelle Sopoliga, Michelle Ocken
2005 Alan Raetz
2006 Khang V. Do, Chris L. Clifford
2007 Adam M. Ferris
2008 Nicole J. Huber
2009 Akiko Masuda
2010 Brandee Stone
2011 Ninette Danielle
2012 Areeje Almasary
2013 Sean Cobb
2014 Charlotte Park and Sisarie Sherry

GR-5

Impact of H5N1 influenza virus replication on macrophage function
Keerthana Sekar keerthanasekar.s@gmail.com
Advisor: Troy Cline tdcline@csuchico.edu

Highly pathogenic H5N1 avian influenza viruses pose a public health risk for their pandemic potential and infect humans with a 60% mortality rate. The disease severity with H5N1 viruses is unknown but is thought to be attributed to a dysfunctional early host immune response. Macrophages being important for protection against infection with influenza viruses, may contribute to disease severity and important macrophage functions are thought to be altered during H5N1 influenza virus infection. Phagocytosis of influenza virus-infected cells by activated macrophages is an important antiviral defense and inhibition of macrophage phagocytosis leads to increased virus replication. Also, IFN-γ mediated macrophage activation of virus infection induces nitric oxide, a potent inflammatory signaling molecule. We demonstrated that H5N1 viruses are unique in their ability to replicate in macrophages in a hemagglutinin dependent fashion. The objective of this project is to determine the impact of influenza virus replication on macrophage function. We hypothesize that H5N1 influenza virus replication in macrophages alters cellular functions in ways that contribute to increased disease severity. Our data shows that macrophages infected with H5N1 were less efficient at phagocytosis and inhibited IFN-γ-mediated activation of macrophages compared to those infected with a seasonal H1N1 virus. H5N1-infected macrophages failed to produce NO in response to IFN-γ stimulation. These changes in macrophage function are dependent on H5N1 virus replication, suggesting that macrophage dysfunction during H5 infection is an effect of the ability of these viruses to replicate in macrophages. This study addresses questions that are central to understanding H5N1 virus pathogenesis.

GR-6

Growth receptor-bound protein 2 (GRB2) overexpression in acute myeloid leukemia
Jesse Smith jsmithlac@gmail.com
for the number of germinations between and amongst each factorial categories with water saturation levels indicating the greatest effect for germinations. These results support the conclusion that WPW is capable of being an aggressive threat to native flora and warrants a rapid and thorough management strategy. Results from this research also have implications for informing management strategies for other potentially invasive spec.

**GR-4**

Migration Patterns of Flammulated Owls Using Light-Level Geolocators

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Advisor: Colleen Hatfield, chatfield@csuchico.edu

Flammulated owls (*Psiloscops flammeolus*) are small nocturnal owls that are thought to migrate long distances every year from summer breeding grounds in the Western United States to winter habitat in Mexico. They are cryptic and elusive cavity nesters and little is known about their migratory patterns. They have been named a Species of Concern by the U.S Fish and Wildlife Service because of potential habitat destruction. The goal of this research was to track the movements of these owls during their migratory season using light-level geolocators. The geolocator records ambient light levels that correspond to sunrise and sunset times to determine specific bird locations. During 2012-2013, 64 geolocators were attached to male and female Flammulated owls in breeding sites in Washington, Colorado, Utah, and California. In 2013-2014, 16 of these geolocators were recovered from birds in California, Utah, and Colorado. The migratory routes of these birds were analyzed using GIS and further analysis was performed to determine kernel density estimates of their winter home ranges in Mexico. This geolocator analysis along with additional research on habitat preferences of Flammulated owls in California is the first step in assessing the current status of this species with the goal of a broader western US effort in the future.

**Recipients of the Michael Abruzzo Outstanding Scientist Award**

*Department of Biological Sciences*

*California State University, Chico*

2006 Collin Biondo, Andrew Anderson, Chelsea Riggs, and Nicole Tunnell

2007 Charissa Becker-Martinez and Freshta Obaidi

2008 Kylene Lang

2009 Akira Iwami and Alena Chin-Curtis, Amir Bagheri, Broderick Illa, Crissy Nelson, Danny Weller, Jonathan Schneider, Jordanna Forman, Justin Peek, Katie Collins, Lee Ho, Lisa North, Meghann Shorrock, Reid Griggs, Robert Marvin, Sanae Burries, Vanessa Cox, and Zaira Jimenez

2010 Melissa Maney

2011 Ellie Oliver and Juan Mota

2012 William McCall

2013 Packard Greer, Branden Hendrix, Taylor Kaizoji, and Courtney Silver

2014 Sophia Somers, Jansen Rinck, Trinity Stirling, and Jessica Leek
Interactions among herbivores sharing common food resources have important ecological implications. The interactions among insects, mammals, and their host plants may affect the dynamics of the herbivore populations. Under some conditions, Columbian black-tailed deer (*Odocoileus hemionus columbianus*) browse on manzanita shrubs (*Arctostaphylos* spp.) in the Big Chico Creek Ecological Reserve (BCCER) near Chico, California. The manzanita leaf-gall aphid (*Tamalia coweni*) induces galls, either along new leaf edges, or, occasionally, along the midrib vein. The purpose of this study is to investigate trophic relationships among Columbian black-tailed deer, leaf-galling aphids, and manzanita plants by examining the numerical responses of the aphids to browsing by the deer. In field trials, I have established vertical partitioning on 70 sampling plants such that each plant is divided into regions either subject to browsing, or excluded from browsing. Here I present preliminary data on *T. coweni* populations as a function of browsing by black-tailed deer.

**Factors Affecting Seed Germination and Emergence of Wingleaf-Primrose Willow (*Ludwigia decurrens*)**

Evan W. Padgett (epadgett1@csuchico.edu)
Advisor: Colleen Hatfield (chatfield@csuchico.edu)

Wingleaf Primrose Willow (WPW – *Ludwigia decurrens*), a potentially invasive weed native to South America, was recently discovered in California Central Valley rice fields. This species is a globally recognized exotic annual weed that is self-pollinating and capable of producing thousands of fertile seeds. An understanding of the seed germination ecology for WPW can assist in predicting its potential local distribution and assist in the development of effective management strategies. An investigation was conducted to determine the factorial effects of three light levels, three water levels, and two location treatments (n=54) on WPW seedling germination and emergence in a greenhouse setting. Overall results were significant.
Graduate Research

GR-1
miR-375 expression in glucose dependent manner in Type II diabetes.
Pablo E. Diaz, pdiaz6@mail.csuchico.edu
Advisor: David M. Keller, dmkeller@csuchico.edu

Micro RNA 375 (miR-375) is a small non-coding RNA involved in the hormonal secretion within pancreatic islets and important for development of pancreatic β-cells and α-cells. In pancreatic islets, miR-375 is involved with secretion of insulin within β-cells, which is responsible for the regulation of blood glucose levels. However, in type II diabetes the overexpression of miR-375 is involved with inhibition of insulin secretion in β-cells but it is unknown whether miR-375 can inhibit glucagon secretion in alpha cells. We propose that the regulation of miR-375 will be fundamentally different between the pancreatic α-cells and β-cells because of different physiological functions in regulation of glucose. To investigate this, we hypothesize that miR-375 levels will drop when glucose levels drop. To answer this we ran a glucose time course in mouse insulinoma MIN6 cells by starving them at a low glucose concentration (5 mM) for 24 hours, administered with high glucose (40 mM) and are harvested for RNA at designated time points (0h, 4h, 8h, 16h). We extracted RNA, reverse transcriptase to synthesize cDNA and performed quantitative reverse transcriptase PCR (qRT-PCR) monitor pre-miR-375 expression levels within MIN6 cells. We will administer the same to mouse glucagonoma αTC1-6 cells. The results indicate MIN6 cells show decreasing expression of pre-miR-375 with extended exposure to high glucose treatments. The pancreatic alpha cells are expected to have higher miR-375 levels when administered with the same high glucose treatments and have lower miR-375 levels with lower glucose treatment.

GR-2
Trophic Interactions among Deer, Manzanita, and Manzanita Leaf-gall Aphids in the Big Chico Creek Ecological Reserve near Chico, CA

Lower Division Class Projects

L-1
Food Size Preferences of Local Birds
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BIOL 152: Mandeep Grewal mgrewal@csuchico.edu

There is no energetic benefit for any organism to seek out a food source that provides less energy than is spent in the process of obtaining it. In this experiment, we hypothesized that birds would prefer eating bigger seeds compared to small ones even when bigger seeds are heavier and potentially harder to crack as they contain more nutrition per seed. On average, the larger seeds were 10.45mm in length and the smaller seeds were 4.25mm in length. We set up trays containing equal amounts of two types of seeds, different significantly in size only, assorted randomly. We left the trays for local birds to feed on over the course of the day undisturbed three separate times for three different days, and then collected data later in the evening. We found that of the bigger seeds, only half as many were eaten at the end of the day compared to the smaller seeds. The relative percentage of small seeds consumed for day 1, day 2 and day 3 were: 60%, 43% and 75% respectively. Combining the results from all three days provided a p-value derived from a statistical t-test of 0.017 for the birds favoring the smaller seeds. For future experiments we would vary the width and weight of the seeds in an attempt to pinpoint an optimum seed choice for local birds.

L-2
Responses of stomatal densities in leaves near a water source and away from a water source
Emily Andes (eandes@mail.csuchico.edu); Berenice Diaz (bdiaz17@mail.csuchico.edu) Nida Ejaz, (nejaz@mail.csuchico.edu); Muhammad Khan (mkhan15@mail.csuchico.edu)
BIOL 152: Rachel Francis (rfrancis4@mail.csuchico.edu)

Living plants ‘breathe’ through tiny openings in leaves called stomata. These openings allow for gas exchange of water vapor and carbon dioxide used in photosynthesis. However, transpiration of water vapor out of open stomata can lead to water stress. Thus, plants need to acclimate (be phenotypically plastic) to varying environmental factors. The factors that affect the number of stomata per leaf depend on
environmental factors such as humidity, temperature, amount of light, and amount of water in soil. The hypothesis in this experiment is that leaves in a wet environment will have a higher mean density of stomata than leaves in a dry environment due to decreased water stress. Fifteen samples of leaves were taken both from near a stream and 15 away from a water source. These leaves were taken back to lab and an impression was made with clear nail polish to count the number of stomata/mm$^2$. Results indicated that samples found away from a water source seemed to have a higher stomatal density (AGV=319, SD=111.70) than the leaves that were found near a water source (AVG=197, SD=74.53). However, there is no significant difference found between leaves near and away from water source (p=0.14). The pattern of the stomata indicates that leaves near water source tend to conserve less water than leaves away from water source due to the number of stomata. These results are important because the data shows the differences between the locations of the leaves and how they are affected by their proximity near or away from a water source.

Stomatal Density Young V. Old
Katerina Arca (karca@mail.csuchico.edu); Andrew Coloma (Acolomachs@yahoo.com); Michael Xiong (mxiong51@mail.csuchico.edu); Pa Xiong (pxiong39@mail.csuchico.edu)

Stomata are pores on a plant's leaf that are used to bring carbon dioxide into the plant, and to release water and oxygen into the atmosphere. We did an experiment to determine whether the age of the plant (*Camelia japonica*) affects the stomata density. We predict that younger plants will have a higher stomata density than older plants because they need more photosynthesis with less leaf surface area to grow. One leaf from a young plant and another from an older plant were acquired, and the plants’ age was deciphered by the girth of the trunk. The girth of the trunk for the young plant was measured to be 6 cm while the older plant was measured to be 17.5 cm. The stomatal density was measured under a microscope at 400x field size. The young plants had an average stomatal density of 59.34 and the older plants had an average of 46.17 under 400x field size (p= 0.01), concluding that our hypothesis is supported by our data. Our results

Valley oak is a majestic California native oak found throughout California's foothills, valleys and flood plains, and is under threat due to habitat loss, low recruitment in remnant stands and climate change. Valley oak is considered a foundational species that shapes the ecosystem and its biodiversity where it is found. To better understand the ecological genetics of factors influencing variation in phenology and other traits in this species, we established a range-wide provenance test. We sampled 674 maternal trees from 95 different collecting sites from across the entire species range. The acorns were germinated in a greenhouse and planted in replicated plots two years later, during January 2015, at the USDA-FS Genetic Resource and Conservation Center, in south Chico. The study has multiple goals, with a primary focus on understanding tree responses to climate change. During Spring semester 2015, we measured traits associated with growth and fitness, as well as response to a changing climate- including phenology. Here we report early findings from the trial based on the first 2 years of growth in the greenhouse and field. We have found significant genetic correlations among traits, and significant variation in the timing of early leaf development.
According to the U.S. Environmental Protection Agency, in 2012 alone, 32 million tons of plastic waste was generated, representing 12.7% of the total municipal solid waste. The majority of these plastics are not biodegradable, however some are made of polyhydroxybutyrate (PHB) or polylactate (PLA), which are examples of biodegradable (compostable) plastics. In previous work, our team has isolated 14 bacterial species based upon their abilities to degrade PHB. These bacteria, collected from three separate environments, were identified based upon 16S rDNA sequence. Herein, we describe the characterization of four of these isolates (Variovorax paradoxus, Bacillus infantis, Comamonas testosteroni, and Acidovorax wautersii). These four species were originally isolated at 28°C, however we found optimal temperatures for growth and degradation were much higher (up to 44°C). Experiments were run to determine if the PHB degrading organisms could also break down the bioplastic PLA. Although there was no clearing of PLA on agar media, Acidovorax was able to grow in liquid media containing PLA as a sole carbon source. The putative PHB depolymerase produced by Acidovorax had a molecular weight of approximately 47 kD based on SDS-PAGE and zymogram analysis. Current and future work will focus on purification, characterization, and regulation of the gene expression for these depolymerases.

UR-7
Range-wide natural variation in Valley Oak (Quercus lobata) phenology in a new provenance test
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Advisor: Christopher T. Ivey (ctivey@csuchico.edu)
was conducted to determine if one of those factors is genetics and was done so by comparing stomatal density in the native California Sycamore (Platanus racemosa) and the non-native London Planetree (Plantus x acerifolia). The London Planetree is a non-native species introduced to California mainly for landscaping purposes because of its tolerance for pollution. The hypothesis was that variation in stomatal density is due to genetic differences in native and non-native sycamore trees. The prediction was that the London Planetree will have a higher stomatal density than the California Sycamore. The experiment was conducted by locating each species of tree in Bidwell Park near the creek about 25m from the shoreline then selecting 10 leaves from each species of tree. Nail polish was applied to the underside of the leaves, then removed with tape and mounted onto a slide for evaluation with a microscope. Stomata were counted in 3 different areas on each of the leaves then averaged before converting the number of stomata per viewing area to number of stomata per mm². The mean number of stomata for the California Sycamore was 178.06/mm² and for the London Planetree 189.44/mm². A t-test was performed showing a t-stat value of -0.99 and a P-value of 0.17 showing that there is no significant difference in stomatal density based on the genetic differences in the two evaluated species. In conclusion, variation in stomatal density is not due solely to genetic differences, but rather more than a single factor. With no difference in stomatal density the London Planetree’s only advantages over the California Sycamore are pollution tolerance and aesthetics.

L-6
Habitat has an Effect on Varying Stomatal Density in Sycamores
Janelle Bettencourt (jbettencourt12@mail.csuchico.edu); Kaitlin Coburn (kcoburn2@mail.csuchico.edu); Daisy Lopez (dlopez24@mail.csuchico.edu)

BIOL 152: Evan Padgett (epadgett1@csuchico.edu)

Stomata are small pores on the underside of leaves that allow for gas and water exchange. It is understood that phenotypic plasticity, change in stomatal density caused by environment, occurs in plants as a coping mechanism for change in environment or habitat. Sycamores, Platanus racemosa, are native to Lower Bidwell Park and planted on the Chico State campus. Stomatal density is hypothesized to vary due to the trees’ location and habitat. Thirty leaves, fifteen

Zebrafish (Danio rerio) are an excellent model vertebrate organism for studying hematopoiesis, the process of blood cell formation. However, little is known about the molecular pathways that regulate this intricate process. In order to discover more about hematopoiesis, in vitro assays must be developed to validate and modulate signaling pathways involved in blood formation, proliferation, and differentiation. A major area of development is creating stromal cell lines that enhance proliferation and differentiation of hematopoietic stem and progenitor cells (HSPCs). Since zebrafish and humans have similar blood systems, our current research is focused on developing and utilizing zebrafish embryonic stromal trunk (ZEST) cells, derived from tissue surrounding the embryonic dorsal aorta, the site of hematopoietic stem cell (HSC) emergence in developing fish. ZEST cells have a beneficial effect on HSPC proliferation and differentiation when HSPCs are plated on top of them. Additionally, ZEST cells cause differentiation of HSPCs down the myeloid, lymphoid, and erythroid pathways as well as significantly increasing HSPC proliferation in vitro when assessed by morphology and gene expression. ZEST cells likely express numerous cytokines that affect the behavior of HSPCs, which in turn aids in understanding pathways involved in their differentiation and proliferation. Molecular control of HSPC proliferation and differentiation is essential for normal blood production- changes in these pathways can have serious clinical consequences, causing a multitude of diseases such as anemia and leukemia. Understanding and modulating these pathways should prove useful in treating these diseases.

UR-6
Characterization of Bioplastic Degradation by Bacteria Isolated from Compost and Sewage
Ryan Sauer rs0311300@gmail.com, Mayson Lin, Daniel Wright, Heather Lawther, Aaron Brown*, Steven Holl*, My Lo Thao*, Daniel Edwards, Larry Kirk, Larry Hanne

Advisors: Larry Hanne lhanne@csuchico.edu; Daniel Edwards djedwards@csuchico.edu; Larry Kirk lkirk@csuchico.edu

*Department of Biological Sciences, CSU Stanislaus
The Mixotrophic Capacities of *Leptothrix cholodnii* (Sp-6)
Megan Jace mjace1@mail.csuchico.edu
Advisor: Emily J. Fleming enuester@csuchico.edu

The environment rarely provides a reliable, steady source of carbon; instead cells are exposed to multiple fluctuating carbon sources. Historically, *Leptothrix cholodnii* SP-6 and other *Leptothrix* species were considered to grow exclusively via heterotrophy, assimilating carbon from pyruvate, glucose, and succinate. However recent genome sequencing of *L. cholodnii* SP-6 indicated the presence of a key autotrophic gene, Ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO), suggesting *L. cholodnii* does not rely solely on organic carbon for anabolism. The specific aim of this project was to determine if *L. cholodnii* SP-6, has the capacity for carbon mixotrophy (to simultaneously gain carbon from two different sources), such as pyruvate and CO$_2$. To test *L. cholodnii* SP-6’s capacity for mixotrophic growth, I grew cells in micro-oxic, CO$_2$-enriched or in oxic CO$_2$-poor conditions. Cells were also examined for the ability to oxidize Mn under oxic and anoxic conditions. I am currently developing a protein assay (using the Bradford method) for use with *L. cholodnii* (SP-6) in the presence of metals such as MnCO$_3$. When grown with MnCO$_3$ and pyruvate under anoxic conditions, colonies grew. No significant difference in protein concentrations were noted between the growth with and without MnCO$_3$, indicating the MnCO$_3$ did not inhibit protein measurements. This research will help us develop models to study the ability for micro-organisms thrive in environments with fluctuating carbon sources.

Zebrafish Embryonic Stromal Trunk Cells Support Formation, Differentiation and Proliferation of Hematopoietic Stem Cells
Payton Laurie (plaurie@mail.csuchico.edu), Brenda Avalos (bavalos@mail.csuchico.edu), Hannah Metzger (hannah.r.metzger@gmail.com), and David Stachura
Advisor: David Stachura (davidstachura@gmail.com)

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BIOL 152: Rachel Schleiger (rffrancis4@mail.csuchico.edu)

Based on the data of previous experiments, stomatal density has been found to be affected by quality and intensity of sunlight. As the presence of sunlight plays a role in the development and production of stomatal density in plants, it is possible that other abiotic factors can affect stomatal density. So, this experiment asks if stomatal density could be dependent on the proximity of water. In this case, the study hypothesizes an increase in stomatal density the closer the plant species is to a natural body of water due to decreasing water stress. Thirty individual leaves of ivy were collected as two groups, one close in range to the body of water and another further in range. The results indicated a statistically significant difference (p<0.002), whereas the closer samples to water had higher average values. These patterns were most likely influenced by the abundance of natural resources to help promote gas exchange without extreme limitations. Data collected in this experiment is important because an individual specimen cannot possibly vary in stomatal density, so data is collected based on the presence or lack thereof abiotic factors.
Effects of Color and Palatability on Predation Rates by Birds
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BIOL 152: Evan Padgett epadgett1@csuchico.edu
Mimicry is the superficial resemblance of one organism by another. The objective of this experiment is to examine the responses of native birds to different frequencies of a mimic “species” while holding the parameters constant. The question is then posed: Can predators (birds) learn that a certain characteristic (color) is not palatable? Our hypothesis states the birds will learn certain colors are not as palatable as others based on color. To test our hypothesis, we collected continuous data testing the effects of color and palatability on predation rates by birds using the experimental prey (safflower seeds). Prey of three colors were presented to the birds. We predicted yellow (fully palatable) safflower seeds would be eaten more than green (3/4 palatable), and green would be eaten more than blue (1/4 palatable). The data was compiled using a chi-square test and was collected over eight days with increments and measurements recorded 3 times daily. From the chi-square test, the results for each day were as follows: 6.375, 3.250, 7.358, 1.600, 1.750, 9.360, 17.400 and 1.000. When compared with a standard chi-square value of 5.991, the values are significant except for Thursday, Friday and the second Monday. This indicates that the birds had learned feeding behavior and effectively chose a prey type with a low number of unpalatable seeds and higher number of mimics. The birds learned certain colors were not as palatable as others based on color, as suggested by our hypothesis.

Root Length and Competitive Advantage of Invasive Centaurea solstitialis
Spencer Carroll (scarroll10@mail.csuchico.edu)
BIOL 152: Mandeep Grewal mgrewal@csuchico.edu
Yellow star thistle (Centaurea solstitialis) has become one of the most widespread and problematic invasive species, out competing native grasses and wildflowers. A study conducted in 2002 indicates that total gross acreage of yellow star thistle in California was 14.3 million acres, an 80% increase from 1985. A deeper root system...
Undergraduate Research

UR-1
Sex In the Dark? Or Leave the Lights On?
Julian Aggio (j.aggio@yahoo.com), Brenda Avelos (beavilos@mail.csu.edu)
Advisor: David Stachura (davidstachura@gmail.com)

Zebrafish (*Danio rerio*) are an excellent vertebrate model to study development. They develop externally and are optically transparent, allowing manipulation and visualization of early embryonic processes, such as the formation of the heart and circulation of blood cells. Additionally, zebrafish are genetically similar to humans and they serve as an excellent model for large-scale chemical screens that may have clinical relevance; drugs are simply added into the water and the fish embryos are observed for phenotypic changes. In fact, there are drugs currently in human clinical trials that were originally discovered in zebrafish drug screens because they expanded the number of blood stem cells in developing fish. However, to perform these chemical screens requires thousands and thousands of embryos. While a zebrafish mating pair can produce hundreds of offspring per week, we hypothesized that we could increase embryo production by altering their breeding conditions. As zebrafish mating is linked to light exposure, we conducted experiments where isolated zebrafish males and females in special breeding tanks were exposed to different colors of light when bred. We tested blue, red, white, and green light, comparing it to no light exposure. These experiments indicated that different color lights had a positive impact on embryo production compared to no external light. These findings should have a positive effect on increasing the numbers of embryos obtained from zebrafish mating, allowing the optimization of large-scale chemical screens and accelerating the rate of drug discovery.

UR-2
Connecting Mercury methylation and the Iron cycle in a California estuarine system
Charles Brooke, Chbrooke@mail.csuchico.edu

would allow moisture extraction from a broader soil horizon giving star thistle a competitive advantage. California brodiaea (*Brodiaea californica*) is a native perennial plant that grows in the open fields of Bidwell Park areas that are also highly infested with yellow star thistle. Significantly longer roots were predicted to be observed in yellow star thistle at locations where it is dominating native species. The study site was located at N 39° 46.8’, W 121°44.9’ an open high exposure field dominated by wildflowers and grasses with occasional basalt intrusions reaching the surface. Thirty 490 cm² plots were established and population counts of both species were taken. In addition, a sample of both species was removed and root length was measured. A total of 147 m² was surveyed and the observed ratio of star thistle to native brodiaea was 3/1. However, the average root lengths of collected samples were statically similar (P value: 0.18); this indicates that factors beyond those considered in this study provide *C. solstitialis* with the competitive advantage over native species. In experimental plots of yellow star thistle rapid extraction of soil moisture has been observed in early pre-flowering growth stages has been observed, this timing could explain the competitive advantage.

L-10
Predation Affecting Seed Dispersal in Box Elder (*Acer negundo*)
Oscar Chavez (ochavez@mail.csuchico.edu)
BIOL 152: Evan Padgett (padgett@csuchico.edu)

Due to plants limited mobility, many use seed dispersal to reproduce. Seed dispersal limits the competition between the parent plant and their offspring. In Samaras, autorotation is a mechanism used to further the distance of the seed. In this experiment Box elder fruit Samaras (*Acer negundo*) (N=60) were released from 8 feet high and their decent time were recorded. Each samara fruit contained a cut on the lower part of the wing adjacent to the seed, resembling a damaged samara attacked by Box Elder Bugs (*Boisea trivittata*). These creatures prey on samara for their seeds, sometimes causing damaged to the wing. Three trials were run and the average rate of decent was taken from the damaged set (Avg. 0.30) and compared to a set without any damage (Avg. 0.40). The main focus was to notice any significant difference between the damaged and the control rates, because the longer a samara is airborne the greater are its chances on landing away from the parent plant. A t-test was used to compare the two rates of decent means. The results (t stat=11.39, df=118, P<1.00E-20)
suggest a significant difference between the two means. The damaged caused by the box elder bug decreases the rate of decent affecting the distant of the samaras.

L-11
Stomata Density and Moisture Content: Comparisons of leaves of Periwinkle (*Major vinca*) close to Big Chico Creek and furthest from Big Chico Creek
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BIOL 152: Mandeep Grewal, mgrewal@csuchico.edu

Stomata density and moisture content was measured between leaves of Periwinkle (*Major vinca*) close to Big Chico Creek and far from Big Chico Creek. It was hypothesized that the Periwinkle leaves furthest from the creek would have low stomata density, due to water loss having a negative correlation to photosynthetic rate. An epidermal peel of the leaves were made and placed on slides, and then the numbers of stomata were counted. Average number of stomata were found (Farthest from creek = 24.16667; Close to creek = 17.83333). Stomata density was also found (Farthest from creek = 7.73333 mm²; close to creek = 5.66667 mm²). Moisture content was also observed. Soil close to creek crumbled when rolled up but presence of water was felt, whereas, the soil farthest from the creek crumbled with no presence of water. An unpaired t-test was then performed on the data (t-stats = 6.81, df = 3, p = 0.006). Based on the t-test results, we would fail to reject our alternative hypothesis that leaves closes to the creek will have more stomata per mm² than leaves furthest from the creek. These data sets suggest that there is a significant difference in the number of stomata in the leaves furthest from the creek and leaves closest to the creek. In order to improve upon our experiment, a larger sample size is required to better calculate the stomata density from the different locations. Having a much larger sample size, will generate a more significant p-value.

L-12
Soil water saturation does not have an effect on stomatal variation density in Valley Oak leaves
Bryn Copson, bcopson@mail.csuchico.edu, Alyssa Weeks, aweeks7@mail.csuchico.edu, and Jonelle Parker

nest boxes a full year of use and most usage occurs during the winter months to fully analyze the experiment and improve methods, if needed.

UD-33
Camera Trap Protocol at Big Chico Creek Ecological Reserve
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A major difficulty for field biologists studying large mammal species is the vast range of areas each species may utilize. The use of camera traps is an effective method of cataloging species in remote and/or difficult to access locations. To effectively use this technology, a user must understand the limitations and performance capabilities of the gear in use. Camera performance depends on several factors including: placement, battery life, memory capacity, seasonal conditions like temperature and sun exposure, motion sensitivity and the cameras themselves. A total of five cameras were set up at the Big Chico Creek Ecological Reserve (BCCER) for a period of three months (March-May). Four brands of cameras were used in order to compare performance, reliability and ease of use. Species observed included bobcat (*Lynx rufus*), black bear (*Ursus americanus*), black-tailed deer (*Odocoileus hemionus columbianus*), striped skunk (*Mephitis mephitis*) and grey foxes (*Urocyon cinereoargenteus*) among other species. The overarching limitation with any study using camera traps is battery life, which is dependent upon camera model, number of pictures taken, temperature, timing of photographs (night or day), and battery type. Although the cameras were checked at least every two weeks for data gathering purposes, each camera would have had enough battery life and memory capacity to last at least a month. In order to fully understand the camera limitations, and to get a greater understanding of habitat use by various species in the BCCER, a future long term study over varying seasons and weather conditions will be required.
and spring. Populations have declined in the past due in large part to the destruction of vernal pools for agriculture and urbanization and may be affected in the future by long term changes in precipitation patterns. Drawing conclusions about frog populations requires consistent long term monitoring. We developed a monitoring protocol using both visual and audial surveys of the Western Spadefoot Toad populations, in remnant vernal pool habitat in Butte County. These ephemeral pools are only filled during spring months. We surveyed for approximately six weeks, from late January to mid-March. In this time we completed 10 surveys. We confirmed the presence of this species in Butte County and provide preliminary index of abundance that can serve as a baseline for future surveys. The survey procedures developed here are robust enough to provide meaningful data for long-term monitoring yet simple enough to be implemented as a part of future CSUC classes. We hope that this method and initial survey data can be the beginning of long-term monitoring be to shed some light on and ensure the survival of this elusive species.

UD-32
CSU Chico Nest box Monitoring Protocol
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Development of a field protocol to monitor activity of cavity-nesting birds in in the riparian corridor on the CSU Chico campus. The goal is to provide and support Western cavity-nesting, native species with as much suitable habitat as possible. Methods are described for initiating long-term monitoring for conducting field research and to evaluate the effectiveness of nest box placement in determining which nest boxes, if any, were being used in this long term study. Three boxes were constructed and placed in the riparian corridor, along with previously placed nest boxes, far enough from the railroad tracks and trees with no obstruction to the entrance of the nest. Consideration for placement was decided based on minimizing disturbance and placing where vandalism could be avoided and/or reduced. Since their placement, there have been multiple observed bird species that displayed interest but none have made it their permanent residence. However, this is meant to be an ongoing, long term project which is necessary to give the

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Stomata are the pores used for gas exchange in plants and when open, release water and contribute to overall water loss in the plant. The purpose of this experiment was to examine if stomatal density differs in Valley Oak (Quercus lobata) trees that were watered vs. trees that had no irrigation. Leaves (n=20) from the Valley Oak trees were collected from one tree located on the irrigated CSUC campus, and one tree located in Lower Bidwell Park. Soil at the base of each tree was significantly different in terms of water content (t=-2.876, df=8, p=.0206).

Imprints of Valley Oak leaves were made and the average number of stomata were determined (CSUC Campus Tree 1 = 536.11 mm²; Lower Bidwell Tree 2 = 478.33 mm²). The results illustrate that there is no significant difference in the number of stomata in the leaves between the two locations (t =-1.266 , df= 17, p = 0.223). Based on the results, we can conclude that soil saturation alone does not significantly affect stomatal variation density in Valley Oak leaves. Therefore, we can assume that stomatal variation is also dependent on other factors.

L-13
Steller Competition
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Many studies have been done on the theory that species that have more similar niches compete more. For some reason this past spring, Steller’s Jays (Cyanocitta stelleri) have begun invading the Chico area from their usual habitat of higher elevation forests. I hypothesized that this invading species would compete much more with native species that it shares similarity of its niche with. I decided to compare the competition between Steller’s Jays and Scrub Jays (Aphelocoma californica) to competition between Steller’s Jays with other songbirds in my backyard. I bird watched at times when all of the groups under examination were present, and record the number of times a bird of one species would chase or attack a bird of another species, which I called “conflicts” as well as the time they were all together. I documented ten such instances, and found the rate of competition between the jays to be .35 conflicts per minute, and the rate between
Steller's Jays and other species to be .08 conflicts per minute. I used a t-test to compare the means and calculated a p-value of .00003. My results support the theory that species with closer niches compete more. In the future I would like to explore the affects that this competition might have on both of the jay species and investigate what the reason for the movement of the Steller’s Jays into Chico was.

L-14
Intermediate Disturbance Hypothesis observed along hiking paths
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The Intermediate disturbance hypothesis (IDH) states that local species richness is maximized at intermediate levels of disturbance, when disturbance is neither too rare nor too frequent. The purpose of this study was to test the IDH by observing the relationship between species diversity of plants and distance from a frequently used trail. Plants species were counted in a 1’x1’ quadrate at distances of zero, one, four, eight and fifteen feet from the trail. The fewest species were found in the trail at zero feet, and the greatest number of species were found one foot from the trail. Beyond one foot, the number of species decreased. The results were found to be significant between some distances, but not others. Species richness was greatest at tone foot because high levels of disturbance in the center of the trail prevented the survival of most species, and the lack of disturbance further from the trail allowed for competitive exclusion. The one foot distance represented an intermediate level of disturbance that allowed for survival of the most species. The results of the experiment are consistent with previous research, and support the IDH. The IDH can be useful in predicting how human activity might influence local habitats, and understanding the effects of anthropogenic disturbance on the diversity of plant species can be very valuable in the fields of conservation ecology and parks management.

L-15
Sunlight Intensity has a Significant Effect on Stomatal Density in White Clover (Trifolium repens) Leaves
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Bacteriophages are viruses that infect bacteria and are thought to make up the most diverse forms of life on the planet. Like all viruses, bacteriophages consist of nucleic acid (usually DNA) and a protein coat. The protein coat may or may not contain an envelope derived from the host cell. Typically, bacteriophages display host-specificity, meaning that a single phage can usually only infect a single host species. The first step in phage infection is attachment of the phage to a host cell. Host-specificity can be determined by the phage’s ability to attach to a given host species. The Biology 476 class isolated and purified several different phages from sewage using different bacterial host strains to select for unique phages. Each lab group was responsible for the purification and subsequent characterization of a unique phage. We determined the concentration of phage in our lysate, the host range of each phage, the sensitivity of each phage to various temperatures, whether the phage was enveloped or non-enveloped, the attachment specificity, and the molecular weights of the various structural proteins encoded by the phage. In conclusion, these experiments reveal fundamental concepts of phage biology and highlight the diversity that exists within this exciting class of organism.

UD-31
Developing Survey Protocols For Long Term Monitoring of a Rare Local Amphibian, the Western Spadefoot Toad, Spea hammondii
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Western Spadefoot toads (Spea hammondii) are among the many species of amphibians which have experienced notable population declines in the central valley of California over the last three decades (Fisher and Shaffer 1996). These frogs breed explosively in vernal pool habitats during late winter
Stomata play an important role in plant survival as they regulate gas exchange and water loss. Stomatal density, number of stomata per mm², can affect the amount of water lost through evaporation. The evaporation of water from plant leaves is a method used by plants to lower leaf temperature and can be influenced by environmental conditions. Therefore, plants grown in heavy sun environments should have a higher stomatal density than plants grown in low sun environments. White clover (Trifolium repens) is a common forage crop used in animal production and ground cover. Leaves from White Clover plants, grown in both the sun and the shade, were collected from the Sheep and Goat Unit at the California State University Chico Farm (n=30), the stomatal densities recorded, averaged, and determined to be significantly different per environment (t-critical=2.05, df=28, p-value < 0.05). On average, the sun leaves had higher stomatal densities (297.03 ± 58.5 stomata/mm²) than shade leaves (186.67 ± 62.6 stomata/mm²). The results from this experiment support the hypothesis that plants grown in the sun have a higher stomatal density than that of shade plants because of water loss regulation in leaves. These results are further evidence that stomatal density is a key component to a plant’s survival and can be used in future tests for plants grown in similar environments.

L-16
*Rosa burway*: Presence of Thorns Contributes to Fitness
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*B. burway*, along with other rose species, produce thorns as a defense mechanism against predators. Roses not only are a gesture of love, they provide vital nutrients for insects, such as bees. For the continuation of a healthy ecosystem *Rosa burway* rely on a defense to ensure a high fitness while also contributing pollen and nectar. The thorns repel predators creating a higher fitness in the *Rosa burway*. It is predicted that there is a positive relationship between fitness and thorn count when there is a predator present because the rose bushes will use the thorns as protection. To conduct an experiment to test the hypothesis, eight, six inch samples were collected from two different *Rosa burway* plants exposed to the same predators. Data was collected on number of thorns, number of damaged leaves, and whether each clipping contributed to a thorn. The results demonstrat-
ed that *Rosa burway* clippings with a higher thorn count had a positive relationship in regard to fitness, due to the presence of flowers. Based on the statistical data (P-value 0.001), the experiment demonstrates that the presence of thorns contributes to higher fitness in the *Rosa burway*. More research could be done to genetically modify the *Rosa burway* to produce a higher thorn count in order to reduce the amount of pesticide usage.

L-17
**Stomatal Density and Its Relationship to Pollution**

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Pollution is the introduction of contaminants into the natural environment that can cause adverse changes. Plants are especially sensitive to pollution not only because of their sessile nature, but because all of the essential nutrients they require are absorbed from the soil and atmosphere. Stomata are responsible for the allowance of gas and water exchange in plants, thus being an essential component in the process of photosynthesis. As photosynthesis is an essential component to the completion of the carbon cycle, how pollution affects this process is concerning. The purpose of this experiment was to test whether car pollution has an effect on the stomatal density of the leaves of *scientific name* (Maple tree). It was hypothesized that the more pollution the tree is exposed to, the lower the stomatal density will be. Two separate sampling locations were located: one with a “high” amount of traffic (urban) and one with a “low” amount of traffic (suburban). Clear nail polish was applied to the bottom of each leaf sample to create an imprint. The number of stomata was counted per field of view and divided it by the area of the field of view, which is 0.15 mm², in order to have stomata per mm². The average stomatal density for the low traffic area was larger than the high traffic area but it was not significantly higher (p=0.183). The age difference between the trees could have affected the result, therefore leading to the rejection of the alternative hypothesis.

UD-28
*A. thaliana* Peroxidase Gene Expression in Transgenic *N. benthamiana*

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This experiment was conducted to attempt to determine the role of peroxidases in both transgenic and non-transgenic plants. Two different plants were studied - Arabidopsis thaliana, of which a peroxidase gene was tagged with Yellow Fluorescent Protein (YFP) and *Nicotiana benthamiana*, which was infected with Tobacco Mosaic Virus and a vector containing aforesaid tagged gene from *Arabidopsis*. Transference of the gene from *A. thaliana* to *N. benthamiana* began with the collection and isolation of the *A. thaliana* DNA. The isolated peroxidase gene AT3G01190 was then assembled with the YFP through PCR using primers and amplified using *E. coli*. From the *E. coli*, the peroxidase gene complex was then transferred to *Agrobacterium tumefaciens* to use as a vector into *N. benthamiana*. The *N. benthamiana* plants were inoculated and, after allowing time for the Tobacco Mosaic Virus to incubate, protein concentrations of both the treated plant and a control plant were collected. The concentration of the protein found in the treated plants was 22.02 µg/µL, while the plants used as a control had a concentration of 12.1 µg/µL of protein. While there was a difference in protein concentrations between the plants, these results are not conclusive due to the lack of evidence that the increased protein concentra-
organ area where Ago7 will show expression by using the yellow variant of a dimerization-dependent fluorescent protein. Tools such as Genevestigator and PSORT produced areas of interest for Ago7 expression in the cytosol and roots of *A. thaliana*. After this information was obtained: the gene was extracted from the *A. thaliana* plant, manufactured into a reporter construct (including YFP), cloned into a pDONRzeo (vector) and transformed into *E.coli* as a host. The plasmid was isolated and subcloned into pMW390 (vector) where transformation of the *Agrobacterium* occurred. The *Agrobacterium* was then reinserted into the *A. thaliana* to promote transgenic growth.

**UD-27**

**Location of Secretory Peroxidase in Arabidopsis thaliana**

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Peroxidase enzymes can be found in plants, animals and bacteria. The peroxidase enzyme is part of a family called the class III secretory peroxidases. Class III secretory peroxidases have several functions in a plant such as oxidizing toxic compounds, removing hydrogen peroxide and synthesizing lignin in the cell wall. This leads to the question: Where in the cell is the class III secretory peroxidase located in *Arabidopsis thaliana*? We hypothesized that a hydrophilic amino acid sequence at the C-terminus would lead the peroxidase to the cell wall and a hydrophobic amino acid sequence would lead the peroxidase to be taken out of the default pathway which would take the peroxidase to the vacuole. In this experiment, we used Genevestigator genechip experiments to look at mRNA abundance in the tissue of root tips in order to pick a class III secretory peroxidase gene of interest. PCR methodology was used to generate fragments of our gene and a second round of PCR was used to group our fragments and Yellow Fluorescence Protein (YFP) and cloned into vector. Primers were designed for the gene AT4G30170. Expression of our gene was verified using gel electrophoresis in order to carry out the experiment.

**L-18**

**Water Proximity Dictates Stomatal Density for Quercus lobata (California Valley Oak)**

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Plants such as the *Quercus lobata* (California Valley Oak) exhibit an adaptive ecological skill called phenotypic plasticity in order to adapt to their surrounding resource availability. In this investigation we focused on *Quercus lobata*’s variation in stomatal densities between arid and moist soil environments. The stomatal opening in a plant controls the uptake of CO$_2$ and the output of water via transpiration. Knowing this and that the Oak tree grows in the presence and absence of water, we wanted to test if the stomatal density would change with the availability of water. We hypothesized that the Oak Trees in moist soil environments would have higher stomatal density than they would in arid soil environments. This process indicates a higher moisture content of the soil environment and thus if the soil had less water the trees could not afford to lose as much water via their stomata. We collected 10 sample leaves from each tree and observed the average density for the tree near water to be 51.57 stomata and the average density for the tree away from water to be 48.67 (p=0.199). This suggests there is not sufficient evidence to support our hypothesis. Our results are inconclusive and do not indicate that the Oak Tree growing near the water would have higher stomatal density. This could be because photosynthesis is not the primary process that dictates stomatal density.

**L-19**

**The Stomatal Density Increases in the Periwinkle (Vinca minor) in High Moisture**

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Stomata are small openings in leaves used in photosynthesis to collect CO$_2$, but in doing so the plant loses H$_2$O and O$_2$ when the stomata are open. We are interested in this topic because when we looked at the stomatal density between leaves in the sun versus leaves in the shade we wondered if the stomatal density could also be affected by the...
amount of water that is available to the plant. We hypothesized that the plants near the water source will have more stomatal density as compared to plants away from the water source. For our method we found two Periwinkle plants (*Vinca minor*) where one plant had more moisture than the other and collected leaves from both plants that were in the sun. The stomatal density was measured under the microscope at 400x field size. The average stomatal density for leaves in the dry environment was 20.06 at 400x field size and the mean for leaves in the wet environment was 33.06, our p-value was 3.18x10^-7. Based on our data we can conclude that plants will increase the amount of open stomata when near a source of H2O. We can genetically modify plants to have fewer stemata so that they can live in a drier environment.

**L-20**

**The Effect of Height on Stomatal Density**

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Stomatal are small pores found everywhere among the lower epidermis layer of plant leaves. The function of stomatal is for gas exchange and transpiration. Transpiration is an important function in which the plant utilizes the water from the plant roots by transporting it towards the leaves. Therefore, does stomatal density increase if the leaves of a tree are located at a higher elevation due to the cause of more transpiration? We hypothesize that if leaves are located higher on a tree, more transpiration will be needed to transport water up towards the leaves, hence, causing an increase in stomatal density. Four leaves were collected from the species East Palatka Holly (*Ilex x attenuata*). Two leaves were collected from the plant at 1 meter and two leaves were collected at 2.17 meters from the ground. The stomatal density was calculated under the light microscope at 400x field size. The average stomatal density of the leaves at 1 meter was 32.5 and at 2.17 meters were 28.6 per 400x field size (p = 0.017). The data shows that height affects the stomatal density. This knowledge could be applied in genetically modified plants to increase survival rate in desert areas of California.

**UD-26**

**Gene Expression of Argonaute 7 in Arabidopsis thaliana**

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The application of transgenesis is rapidly growing in the modern Molecular Biology field. Utilizing this method, genetic material is isolated from one organism (transgene) and inserted into another organism in order to express extraneous genes due to the organism’s genetic code similarities. This application can be used beneficially to gain a greater understanding of the mechanisms functionality in gene expression of transgenic organisms. In order to achieve this, a gene is being used from the Argonaute family known as Argonaute 7 (Ago7) which is a protein coding gene for the regulation of heterochrony in *Arabidopsis thaliana*, by associating with silencing RNAs (siRNA) which affects the expression of other genes. The purpose of this experiment is to track the subcellular and the tissue or role in DNA repair. Online bioinformatics tools were used to examine three different Argonaute genes, and to predict where in the plant they would more likely be highly expressed, as well as to predict where in the cell these genes would be expressed. The bioinformatics tools indicated that Ago 2 is predicted to be localized in the cytoplasm. However, Ago 7 is more ambiguous, it was predicted to be either in the cytoplasm or nucleus. Ago 7 and Ago 2 were then chosen to be engineered with YFP reporters because the heat map tool predicted a strong expression in the roots, and because the size of the genes made recombination a viable technique for the creation of transgenic organisms. Ago 2 was transferred into *Arabidopsis thaliana* and Ago 7 was transfected into leaves of a tobacco plant. The transgenic *A. thaliana* plant showed positive expression of the modified Ago 2 gene by fluorescing within the plant’s root structure. In the tobacco plant, the modified Ago 7 gene was positively expressed in the leaves. In conclusion, the two modified Argonaute genes were positively expressed in both plants used in our studies.
a class III secretory peroxidase in Arabidopsis thaliana that was strongly expressed in the early stages of plant development and tagging it with a yellow-fluorescent protein provided a visual confirmation of where the peroxidase was located. Once the peroxidase gene was tagged with YFP, the gene was cloned and transformed into Escherichia coli and then into the final vector Agrobacterium tumefaciens. A. thaliana was then inoculated with A. tumefaciens by floral inoculation. The infected seeds were later collected and grown on petri dishes. The roots were examined under the microscope which showed yellow fluorescence in certain parts of the root. Fluorescence was present in the roots, but it wasn’t evident if it was restricted to the cell wall. Certain parts of the root fluoresce more than others. Further research would be required to verify whether the peroxidase is localized in the cell wall or not. Understanding the process of lignification through class III secretory peroxidases can support the development of renewable fuels. These renewable fuels such as ethanol, biodiesels and other hydrocarbon fuels can be derived from biomass feed stocks like cornstarch, crop residues and woody plants.

UD-25
Argonaute genes with yellow fluorescent protein: testing expression of argonaute 2 and 7 in transgenic Arabidopsis thaliana and Nicotiana benthamiana
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Genetic engineering has widely been used by scientists in order to identify in organisms sections of interest in their genome, which allows at the same time to have a better understanding of their biological functions, protein interactions, and even gene regulation. In this way, scientist can have the power to manipulate these small pieces of information in order to bring future benefits to their development. In our experiment, we focused on the Argonaute (Ago) gene family in Arabidopsis thaliana. This family of genes is of interest due to their roles of post transcriptional gene silencing through RISC complexes and gene silencing during translation, as well as their possible

L-21
Worm Abundance Correlates with Distance from a Water Source
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Water is an essential component to life on Earth, such as the life of the Earthworm in a soil ecosystem. This investigation tested the abundance of Earthworms through a gradient of soil moisture correlating to a distance away from the Big Chico Creek. The prediction was that worm abundance would decrease with less access to water availability. Worms were counted at ten feet intervals from the creek in a 125 cubic inch hole and subsequently, soil samples were measured for soil moisture at ten feet intervals from the creek. By linear regression, the results were found to be significant; worm abundance decreased with distance from the creek bed (P=0.016). In future investigations, worm abundance can be tested radially from the creek as opposed to orthogonally. New methods can be applied such as utilizing a t-post driver to quickly remove samples. This experiment showed that earthworm abundance correlated with distance from a water source; other lifeforms can be studied in a similar matter.

L-22
Plant Species Richness in a Ridge vs. Wetlands Habitat
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Different habitats allow for more species to thrive due to several factors including water availability, habitat alteration, and invasive species. For the purpose of this experiment species richness was compared in a ridge habitat in Upper Bidwell and a wetland habitat at Llano Seco. In order to determine species richness in these habitats, data was collected from 15 random samples using the quadrant method. It was found that the average number of species was greater in a ridge habitat compared to a wetlands habitat (p-value=1.11 x 10^-6). This pattern is due to the varying environment in a canyon habitat, while a wetlands habitat is rarely dry and thrives when it is flooded.
Results in this study can allow us to determine if species richness is decreasing in certain areas over time.

**L-23**

**Periwinkles Show Little Variation in Stomata Density with Accordance to Soil Moisture Content**

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Plant stomata collect CO$_2$ for photosynthesis, release and collect water vapor, and conserve energy. They are capable of opening and closing based on environmental conditions. California’s current water conditions caused us to speculate if plants will conserve their resources when the soil conditions become less water saturated. The goal for this experiment was to determine the effect of water soil content on stomatal leaf density. The hypothesis for this study is that Periwinkles located in soil with a low moisture deficiency will have higher stomata density than plants located in higher moisture deficiency, due to lacking the need to conserve water vapor to prevent dehydration. Five leaves were obtained from two separate plants, one with low moisture deficiency and the other with higher moisture deficiency. The moisture of the soil was determined by hand using a soil moisture interpretation chart. Each leaf was analyzed with 100x under a microscope, on three different areas per leaf. The mean from plants with low water deficiency (5-10%) was 2.67, mean from plants with higher water deficiency (25-30%) was 2.07 (p-value 0.075). In conclusion, the hypothesis could not be proven, there is no statistical difference between plants located in different soil moisture content. It is possible that the selected variation in soil moisture content was not great enough to cause plants to reduce stomata density to prevent dehydration. Future implications are to select plants from two extremely different moisture levels.

**L-24**

**Inorganic versus Organic Walnuts Based on Squirrels’ Preferences**

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**UD-23**

**Identification of intracellular location of Ago7 in Arabidopsis thaliana**

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In Arabidopsis, Argonaute 7 (Ago7) has been shown to play a significant role in mediating the DNA double-strand breaks (DSB) by recruiting DSB-induced small RNAs. The objectives of this study are to monitor the intracellular location of Ago7 in vivo and to increase our understanding of roles of Ago7 in plant cells. Based on PSORT website, we hypothesized that Ago7 will stay in the cytoplasm due to its lack of KDEL and NLS peptide sequence. Here we generated a reporter gene with fusion between Ago7 and yellow fluorescent protein (YFP) through ttPCR( tri-template PCR), and it was subsequently cloned into Agrobacterium tumefaciens in order to infect and produce transgenic Arabidopsis thaliana. The results from fluorescent microscopy have shown that the expression of Ago7 is low at the root tips. In order to further confirm the expression of both Ago7 and YFP in transgenic plants, Ago7 with YFP cloned into A. tumefaciens were injected and overexpressed into tobacco plants, and the leaf tissues were used for subsequent SDS-PAGE analysis.

**UD-24**

**Function of Class III Secretory Peroxidases by Determining Its Location in a Plant Cell**

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Class III secretory peroxidases are important enzymes involved in multiple physiological process that are widely distributed throughout the plant kingdom. These peroxidases may be involved in the process of lignification. Lignin is a structurally diverse polymer that provides waterproofing and structural support in plants. The final destination of the peroxidase may help determine if they participate in the process of lignification. By selecting
use in *Agrobacterium tumefaciens* for the transformation of *Arabidopsis thaliana*. After inoculating flowers, seeds were harvested, sterilized, and allowed to germinate. Subsequently, root tips were examined under UV light to assess the fluorescence for the presence and location of the reporter gene in the transgenic plants. Fluorescence was noted in the root tips, but was inconclusive for the presence of the reporter gene. This study was unable to identify the location of class III secretory peroxidase gene AT3G01190. Additional attempts to confirm the cellular location of this gene (and others) should be made in order to contribute to the investigation of peroxidase role in lignification.

**UD-22**

**Argonaute Gene Expression in Tobacco Leaves**

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Through the process of creating transgenic organisms we can help better understand the mechanism and utility of specific genes. Advances in genetically modified organisms can prove to be beneficial in many fields, ranging from biotechnology to agriculture. We studied the argonaute 7 (AGO7) gene, which is involved in the RNA silencing process, playing an important role in translation of proteins. Argonaute is one of the four primary classes of proteins to achieve regulation of gene expression and ability to mount an antiviral defense. This regulatory sequence could have drastic effects on development, if over or under expressed. Through the use of *Agrobacterium tumefaciens* we isolated the Argonaute 7 gene and used tri-template PCR to produce a fusion protein with YFP to contain a yellow fluorescent protein tag. The transformed cells were used in addition with the viral promoter, so we could visualize the overexpressed protein using SDS-PAGE. We used bioinformatics software such as Genevestigator, TAIR, and PSORT to predict the location of AGO7 in *Arabidopsis thaliana*. Using these tools, we predicted the Argonaute 7 gene to be expressed in the cytoplasm. The experiments are still being carried out and we are awaiting results.

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According to the optimal foraging theory, given the choice between two food choices, it would be assumed that the more quality and calorie rich foods would be preferred. In this experiment, the objective was to determine whether or not squirrels had a preference for quality given two different choices in walnuts being organic and inorganic and if they were able to learn to eat the organic nuts over the inorganic one. This would be carried out by placing two separate groups of random amounts of nuts in an area where squirrels are heavily populated. Nuts would be placed at random with random amounts of inorganic to organic nuts in two separate areas so that both types of nut would equal 18 samples. A chi-square test was used to determine the significance over the week. When calculating the data it was determined that Tuesday as well as towards the end of the week, namely Friday and Saturday, yielded the most significance with Chi-Square values (5.98, 12.46, and 5.98). Thus giving significant values for Tuesday (p=0.05), Saturday (p=0.005), and Friday(p=0.05). This data shows that towards the end of the week, the organic was preferred. This is significant due to the idea that this species eventually had a preference for quality as the week progressed.

**L-25**

**The Effect of Disturbance on the Fitness of Dandelions**

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The *Taraxacum* genus of angiosperms (better known as Dandelions) are known to be one of the most common types of weeds in the Northern Hemisphere. Dandelions have become well-adapted to “disturbed” habitats because their seeds can spread farther and faster than most angiosperms. These few key features are what set their fitness level above most competitors. The main question in this experiment was to understand if the fitness level of dandelions is affected by differences in levels of disturbance. The hypothesis was that contrasting levels of disturbance will cause differences in the phenotypic plastic traits of dandelions. The prediction was that dandelions in high disturbance areas will, on average, have lower density, height, width of flowers, and number of flowers than dandelions in low dis-
turbance areas. To measure this, sections of habitat were identified in high or low disturbance areas (proximity to sidewalk, trees, buildings, etc.) and analyzed the dandelion populations within those sections. The numbers of flowers per plot, the number of seeded dandelions, as well as each individual flower or seed plant height was recorded. For the plants that did have a flower, the width of the flower was measured. Although dandelions are well equipped for disturbance, the level of disturbance can have an affect on the phenotypic traits and fitness of dandelions. On average the dandelions in low disturbance areas have a higher plant density, plant height, number of flowers and width of flowers than the dandelions in high disturbance areas.

L-26
Effects of Photosynthetic Substrate Presence on Distribution of Triteleia laxa
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Given the importance of light to photosynthetic plants we extrapolated that the role of sunlight would further the development of *Triteleia laxa* in areas that experience sun to a greater extent. This plant is native to Northern California, including local Bidwell park, occurring mostly in grassy areas east of Horseshoe lake. The experiment was conducted to determine whether the selected plant would flourish more on the southern region of Monkey Face which experiences more sun in comparison to the northern region which experiences less sun. To acquire randomized data a die was rolled with each number representing a different direction (north, south, east and west). Once rolled the direction was chosen, ten large steps were taken and a 0.5 m² quadrat was thrown 30 times on each hillside. The number of flowers within the quadrat were subsequently counted and recorded. It was observed that *Triteleia laxa* was significantly more prevalent (p=0.00004) on the northern region of Monkey Face. High anthropogenic disturbance on the southern hillside most likely influenced these results. Further tests need to be done to discover how sensitive this species is to this type and intensity of disturbance. The intermediate disturbance hypothesis states that species richness is hindered in areas of both high and low disturbance, which may account for the lack of abundance of *Triteleia laxa* on the southern hillside. The resulting data displays the importance of understanding how these hydrogen and oxygen. In addition to this function it is also thought that peroxidase plays a role in the lignification of cell walls in the xylem. Using a series of genetic tools online we predicted that the peroxidase from the gene AT3G01190 would be expressed in the cell wall along the zones of elongation and at maturation in the root tip. In order to test this hypothesis, we tagged the peroxidase gene with the gene for yellow fluorescent protein using polymerase chain reaction, cloned our tagged gene into plant transformation vectors, transformed *Agrobacterium*, and infected plants with the bacteria to see where the gene is expressed in transgenic plants. We looked at the infected root tips under a fluorescent microscope and confirmed the location of peroxidase in the center of the zone of elongation of the root tip, where the predecessors of xylem cells reside. To ensure our tagged peroxidase is in the location we detected we can self-cross the transgenic plants, grow the resulting seeds, and look for the tagged protein in the new generation of plants.

UD-21
Investigation of the Cellular Location of Class III Secretory Peroxidase Gene AT3G01190 to Assess Role in Lignification
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Class III secretory peroxidases are a family of enzymes that are suspected to support lignification in plant cell walls. Their role is to create radicals of various hydrophobic lignin monomers, which subsequently bind together, to create diverse lignin polymers in order to provide structural integrity and pathogen defense. This project sought to assess peroxidase involvement in lignification by confirming the presence of peroxidase in *Arabidopsis thaliana* at the cell wall. Using genetic databases, the gene AT3G01190 was chosen based on strong expression in the elongation zone of root tips and molecular cellular destination indicators (presence of peptide cleavage site, lack of KDEL sequence, and hydrophobic c-terminus amino acids). Primer pairs were designed to amplify AT3G01190 with a yellow fluorescent protein insertion, using PCR to generate the reporter gene. Transformation, cloning, and sub-cloning techniques were used to clone the gene into a plasmid for
from the inoculated plants were collected and grown on agar plates containing the antibiotic Kanamycin to select for positive transformation. We found, through microscopic identification of fluorescence, evidence of the Ago 7 expression in the root tips of several germinating plants. The fluorescence observed is more intense and distinct than in controlled plants which indicates a successful transformation of the Ago 7 gene into \textit{A. thaliana}. From this we concluded that the gene AT1G69440 expression is present in the roots of \textit{A. thaliana}.

**UD-19**  
Overexpression and general localization of Argonaute 2 (AT1G31280) gene in \textit{Arabidopsis thaliana}  
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The Argonaute gene family is prominent amongst a wide variety of species, including \textit{Arabidopsis thaliana}. There are 10 different variations of the Argonaute gene within the \textit{A. thaliana} family, our research focused on Argonaute 2 (AT1G31280). It is hypothesized that the Argonaute gene plays a major role in the translation of mRNA into active protein, gene silencing, and potentially inhibits plant growth and viability. Through the method of transgenesis, a Yellow Fluorescent Protein (YFP) was transformed into AT1G31280 which allowed for the tracking of that specific gene in \textit{A. thaliana}. Our research localized the expression of Argonaute 2 and established evidence to support its function in \textit{Arabidopsis thaliana}.

**UD-20**  
Determining the Location of the Peroxidase Protein in \textit{Arabidopsis thaliana}  
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Vascular plants produce reactive oxygen species as a normal part of respiration. In order to break down these toxic substances down they produce an enzyme called peroxidase which turns them into types of disturbance patterns affect species behavior and what can be done to conserve their habitat.

**L-27**  
Canopy Coverage  
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All trees vary on the amount of canopy coverage they have depending in this species. However, they can also vary depending on if there is a presence of opportunistic vine growth. The hypothesis here is that trees with vines will have a smaller canopy than trees without vines. Canopy coverage was estimated for 15 trees with and without vines. Results showed that the average canopy coverage was for trees without vines was 46% higher than trees with vines and was found to be statistically significant ($P< 0.05$), $P= 5.37751E-09$. This pattern may appear due to size and/or morphology of the bark for the trees. The results are essential for understanding that vines strip nutrients from trees.

**L-28**  
The Effects of Bryophyte, Moss, Growth Relative to the Distance from Chico Creek  
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Mosses are very important during the early stages of ecological successions. They stabilize the soil surface thereby reducing erosion while at the same time reducing the evaporation of water making more available for succeeding plants. The aim of this study was to analyze the effect of growth on Bryophyte (moss) relative to the distance from water. This study was conducted on rocks located along the Chico creek, at one mile. It was hypothesized that there would be an indirect correlation between the distance from water and moss growth; as distance from the Chico creek decreased, the density of moss growth would increase. Thirty samples were taken along the Chico creek, all at various distances from the water source.
collected demonstrated a significantly greater moss density when located closer to the Chico creek (P=0.0046). These results showed that moss growth/density was greatest closer to the water source, allowing for other plant life to establish along the creek bed.

L-29
The Effect of Water Proximity on Stomatal Density in Common Periwinkle Plants
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Stomata are structures, found in the epidermal layer of leaves, which let in carbon dioxide for photosynthesis and release water for transpiration. Transpiration is a negative pressure caused by evaporation of water that pulls water through the ground of a plant’s vascular system. We are interested in stomatal density and in finding out the effect the distance from a source of water will have on the stomatal density of a leaf. We hypothesized that a plant closer to water would have a higher stomatal density, than that of a plant further from the water. This is because the plant will obtain water more readily due to the proximity of water, and therefore will need to do less transpiration. We used Common Periwinkle from Chico State campus. We picked four leaves from plants that were 2 meters and 15 meters from Big Chico Creek. The stomatal density was calculated using a microscope on 400X field size. At 2 meters from the creek the density was 22.75 and at 15 meters was 25.73 (P=0.19). In conclusion, it was found that distance from a source of water does not affect stomatal density. Future research should look at other factors, such as carbon dioxide, that may have a greater effect on the stomatal density.

L-30
Effects of distance from water source on plant density and percent coverage in White Meadowfoams
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of a specific peroxidase protein. Ideally the protein location will offer insight regarding the protein’s function. Bioinformatics information available from Genevestigator was used to identify a specific protein, PER27, located at the gene locus AT3G01190 and is expressed in Arabidopsis thaliana plant root tip elongation zones. Experimental methods worked by isolating the gene for PER27 and inserting a Yellow Fluorescent Protein (YFP) marker. The modified gene was inserted into a plasmid and sub-cloned before inserting the plasmid into Agrobacterium tumefaciens. The A. tumefaciens containing PER27, was recombined with Tobacco Mosaic Virus (TMV) which we inserted into Nicotiana benthamiana via leaf infiltration. Following infiltration, portions of the infiltrated leaves were cut and evaluated using fluorescent microscopy to visualize YFP expression of our gene. Successful evidence of expression was found within the infiltrated leaves of N. benthamiana by YFP. From this evidence, we were able to quantify the amount of peroxidase proteins made by TMV and validate our hypothesis.

UD-18
Tracking Argonaute Expression in Arabidopsis thaliana using AT1G69440 (Ago 7)
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Argonaute genes are found in most animal cells and land plants. They are one of the main protein involved in the RNA-induced silencing complex (RISC). This complex binds to microRNA (miRNA) and guides silencing proteins, like Argonaute, to mRNA for repression of DNA. We predict that these Argonaute are endonucleases used as a splicer of both miRNA and siRNA under catalytic or noncatalytic function. Using the Genevestigator interface, we selected AT1G69440 (Ago 7) of Arabidopsis thaliana as our study subject. From the UniProt website we found that the Ago 7 gene was expressed in leaves, floral buds and at low levels in roots. A reporter construct with Yellow Fluorescent Protein was created using a tri-template PCR reaction and cloned into the pDONR211 entry vector and also into the PMN20 destination (recombinant) vector, both sub-cloned by Escherichia coli. Agrobacterium tumefaciens, transformed with our recombinant vector, was re-suspended in 5% sucrose with 200 µM acetosyringone and used to inoculate A. thaliana flower buds. The seeds produced
**UD-16**

Driving Factors in Dispersion Patterns of Trees Near Deer Creek Highway
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The spatial dispersion of differing tree species in a common environment is an important aspect to understanding coexistence. While many different tree species can be found in the same habitat, it is important to note how they have allocated themselves in order to thrive. This study aims to identify the main causes for prominent dispersion patterns amongst five tree species located along a trail off of Deer Creek Highway in Chico, California. Data were collected using a fifty meter transect down the trail with five ten meter squared quadrats along each side. Percent cover, frequency, and density for all five species, *Notholithocarpus densiflorus*, *Cercis occidentalis*, *Pinus ponderosa*, *Umbellularia californica*, and *Fraxinus latifolia*, were documented along either side, noting that there was a prominent clumped distribution for several of the species in each quadrat. Dispersion patterns indicate a clear dominant species, *Notholithocarpus densiflorus*, along both sides of the transect. The results of the statistical analysis gave an importance value for *Notholithocarpus densiflorus* of 1.17 and a p-value of 0.88 thus concluding that the data show no significant correlation between the clumped dispersion of trees and interspecific competition amongst them.

**UD-17**

Synthesis and transformation of *Arabidopsis thaliana* genes by tobacco mosaic virus for the production of modified proteins
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In general, plants absorb most nutrients from the soil they grow in. The location, acidity, and the makeup of the soil determines what nutrients are available to the plant. *Limnanthes alba* is native to Oregon and California and is a herbaceous plant that grows well in soils with a pH of 6.2, especially when located on slopes of refined hills. The objective of this experiment was to determine if plant density and percent coverage is influenced by distance from the main water source. Considering that *Limnanthes alba*, grows abundantly in moist living conditions such as vernal pools and wet grassy areas, it was hypothesized that plant density and percent coverage would increase the closer the water source was. The experiment was conducted on Table Mountain (Chico, California) and 30 random samples were taken with a ft. sq.² plot to observe a reliable pattern. Within each plot, the individual flowers were counted as well as the percent coverage. The distance from the plot to the water source was measured in inches. The results indicated that there was an insignificant difference for both count (p=0.449) and percent coverage (p=.643) in the effects of distance from the water source. People use the seed-oil from *Limnanthes alba* for skin-care and bath products. It is threatened due to grazing and recreational development.

**L-31**

Stomatal density varies between young and old trees
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Stomata play a major role in the survival of leaves. The density of leaf stomata, for example, influence both the rate of carbon fixation as well as water loss. Without stomata, leaves would fail to regulate. We tested the hypothesis that saplings will have greater stomatal density because they need to reduce their water intake more rapidly than older trees because they are more phenotypically plastic. We obtained 10 leaves from a mature box elder and a sapling box elder found in Bidwell Park. We examined the epidermal peel of the leaves under a microscope and counted stomata. The results were entered into Excel and a T-test was performed. Stomatal density averaged 8.5 stomata per leaf higher in leaves from a sapling than leaves from a mature tree, but this difference was not statistically significant (P=.1370). Leaves from the sapling had a standard deviation of 9.75, while leaves from the mature tree had a standard deviation of 10.71. Our hypothesis was not supported, and the results suggest that stomatal density is
not phenotypically plastic. Stomatal density in our system may be under stronger genetic influence, rather than environmental control.

L-32
**Relationship between number of thorns and soil moisture content**

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In order for plants to grow different organs such as thorns, flowers, and leaves, it is essential that there is a good amount of soil and water provided to the plant for adequate growth. We are interested in the effect of this water saturation on plant growth patterns. Plants with high soil moisture will have a higher thorn density than those in soil with low moisture content because there will be more water to use in growth. For our methods, we choose to select three plants of the same species within the rose family, from two different locations. Our first location was within 5 feet of the creek and had soil moisture content of 100-75% and our second location was approximately 30 feet away from the creek with soil moisture content of 50-25%. To collect our data, we counted the number of thorns from the cotyledon of the plant to the first leaf. The number of thorns on the higher soil moisture content was 17, 15, 23; and number of thorns from the lower soil moisture content was 40, 44, 32 (p-value of 0.0089). It is possible that thorns are a necessity for these plants to grow, despite the amount of energy that may be available. For future experiments, research on predation should be conducted to find out more about how thorns affect the fitness of these plants.

L-33
**Stomatal density variation based off distance from water source**

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Stomata are pores in the leaf that regulate gases and contribute to overall plant water loss and has an effect on stomatal density. Plants immobility, which makes plants more susceptible to environmental

Santa, and *Heteromeles arbutifolia*, Toyon. Using a t-test to compare density between the two habitats provided a p value of 0.013. The t-test for percent cover provided a p value of 0.0005. The significance of this data supports the hypothesis that Western Sycamores are more prevalent near the creek, as is the abundance of biodiversity. The four plant species counted were more prevalent near the creek than the interior valley.

UD-15
**Estimating Importance Value and Dispersion Patterns in Trees**

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In order to determine the dispersion patterns of tree species found in the coniferous forest of Butte County, the point-quarter sampling method was used to obtain a better understanding of the existing species. The point-quarter sampling method determined the importance value using density, frequency, and dominance of three species found in the study area. The main species of interest were Douglas-Fir (*Pseudotsuga menziesii*), Sugar pine (*Pinus lambertiana*), and tan oak (*Lithocarpus densiflorus*) as they were some of the most predominant species found in this area. It was hypothesised that the disbursement of these tree species would be a consequence of spatial heterogeneity affecting the adaptation, species diversity, community stability, and competition found in this ecosystem. This would have a major effect of the distribution of these trees. The intraspecific competition between the tree species was also determined to be a factor among them as the disbursement of trees seemed to be affected by the surrounding species of trees. It was determined that the distribution of trees was random in areas affected by clear cutting or natural factors, however, in areas with high density tree presence the species found were usually determined by the surrounding species of trees. Aggregation decreased as size class increased in both species except the Douglas- Fir which suggests that proximity to the other species increases survivorship among all three trees. This may be attributed to its partial-shade intolerance, unlike the other tree species which are shade-intolerant.
Typically, riparian zones have greater biodiversity than upland areas. According to Lasky et al. (2014), biodiversity directly relates to ecosystem function over time. Measuring the different species of trees and shrubs near the creek and in the interior valley can provide data for ecologists to determine biodiversity, and thereby the health, of riparian habitat. The hypothesis was that Western Sycamore trees grow more abundantly near Big Chico Creek and Valley oaks are more profuse in the interior woodland. This study examined two areas in Upper Bidwell Park: the Yahi Trail along Big Chico Creek as well as habitat in the interior valley. Using the quadrat method and random sampling, plots of 5 m² by 5 m² were measured for the presence and abundance of two tree species, Platanus racemosa, Western Sycamore, and Quercus lobata, Valley Oak. To test for biodiversity, two shrub species were also counted: Eriodictyon californicum, Yerba

The purpose of this experiment is to determine the variation in biodiversity in the same creek due to varying oxygen conditions found in that creek at 5 Mile Recreation Center in Bidwell Park. This experiment hypothesizes the more oxygen present in the water, the higher the biodiversity index value (BIV). Three samples from different oxygen leveled zones in the creek were taken and then the amount of specimens collected along with the different species observed in each zone were compared to determine our BIV. A 2-tiered t-test was conducted to determine the statistical significance of the difference observed.

The question explored in this experiment is how foraging of Western Gray squirrels (Sciurus griseus) varies in tree-dense environments compared to environments with less-dense tree habitats. The goal of this study is to observe whether squirrels will forage their food closer to trees or further away from the trees in a forest environment. To measure the foraging success of Western Grey squirrels, three trees were located with known squirrel activity. The first two days of the experiment were used to condition the squirrels to the placed sunflower seeds, and seed counts were not recorded. After conditioning there were five days of data collection. Six trays were constructed of local vegetation and 50 raw sunflower seeds. One tray was placed directly under each tree, and one 20 feet away from each tree. Each day seed counts were performed on each tray and recorded. After five days of collecting seed counts, the data was inputted into Microsoft Excel for data analysis. A chi square analysis was run on the raw data, resulting in significantly more foraging under trees (p=0.00001) than when seeds were placed 20 feet away (p=0.007632). These results are significant in depicting the importance between the availability of trees and gray squirrel foraging success.
L-35 The Effect of Human Populations on Squirrel Behavior
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Animal behavior is affected by many different types of stimuli including natural and anthropogenic. In a heavily populated human environment, it is predicted that wildlife would be less likely to exhibit natural behaviors than those residing in less human populated areas. The Western Grey squirrel is one species that is found readily in both rural and urban environments. This experiment hypothesizes that Western Grey squirrels are more likely to hide and climb in an environment inhabited by many humans. Also it is hypothesized that the squirrels will be less likely to interact with other squirrels and forage in a more human dense habitat. To test this hypothesis squirrel behavior was observed for 1 hour intervals for 3 days in both human-dense and less human-dense habitats during the late afternoon. In the human dense habitat, it was found that squirrels would often hide and climb more than squirrels would in the less human-dense habitat. Squirrels in less human-dense habitats were found to forage and interact with other squirrels. Western Grey Squirrels appeared to be more comfortable and relaxed in less human-dense habitats allowing them to do what they need to do without being disturbed. It is important to note that in a more human-dense habitat squirrels are uneasy and do not always act as they would in their own habitat.

L-36 Comparing Species Diversity on Flat Surfaces vs. Sloped
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Surface structure (aspect) based on geomorphology influences how much light intensity and quality plants get. Just this abiotic factor alone can regionally influence plant distribution and richness pat-

are a more natural habitat with more predation and chance for competition. The experiment was performed by placing 150 seeds in organic trays and putting them in a rural habitat and an urban habitat. The experiment had two days of preliminary trials to acclimate the squirrels to the seeds, and ten days of data collection. Seeds were replaced every day and counted. Results indicated that foraging by gray squirrels in rural areas was significantly higher than urban areas (p=1.22E-06). Human encroachment on natural squirrel habitat has significant impacts on optimal foraging behavior. Squirrels in urban areas could be using unnatural food supplies from humans (bird feeders, etc.) and have more disturbance from domestic pets and traffic.

UD-12 Species-Area Curves in Oaks and Galling Wasps
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According to the theory of island biogeography, the number of species in an area and its species richness is directly correlated with the area size. Typically, larger numbers of a species and greater species diversity are found in larger ‘islands’, or isolated habitats. In our experiment, we counted the number of galls and gall types on oak trees in Bidwell Park. We hypothesized that there would be a correlation between species richness and tree size in which larger trees would have more diversity of gall wasps. We separated the measurements into two categories; between large trees, which were considered to be 0.75 meters in diameter (DBH) and larger, and small trees, which were considered to be below 0.75 meters (DBH). The results produced a p-value of 0.25. With the p-value being larger than 0.05, there is no significance between species richness in large oak trees as compared to small oak trees. According to the results, we fail to reject the null hypothesis, no correlation, and reject the alternative hypothesis in which there is a relationship between the size of the tree and the diversity of the wasps. There also could be some points of error in our experiment. The trees that were larger than 0.75 meters in diameter often had their branches out of reach. This could have led us to observe and collect a smaller sample size than what was actually in the tree and therefore skewing the results.
**UD-10**  
**Effect of Allelopathy on Germination of Radish Seeds**  
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BIOL 350: Shelly Kirn (sakirn@csuchico.edu)  

Allelopathy refers to the biochemical stimulatory and inhibitory interactions of plants, fungi, and microorganisms. The secretion of inhibitory allelopathic substances which reduce the ability of surrounding plants to grow and reproduce is an effective method of alleviating competition for many plant species. Extracts from five potentially allelopathic plants were collected and applied to radish seeds to test whether radish seeds germinated or not in the presence of potentially allelopathic chemicals. Seeds were watered once a day and left in the sun to germinate. The results from each of these test groups were then tested against a control group to determine whether there was a significant difference between each of the test groups and the control group. Germination inhibition was seen with the one treatment of leaf extract in a majority of the trials, with some trials having seeds that did not germinate at all. Evidence points toward allelopathy in plants inhibiting germination of competing plant seeds.

**UD-11**  
**Foraging Ecology: Optimal foraging in Western gray squirrels between urban and rural areas**  
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Foraging for food comes at a price for some animals. Factors such as energy output, location, and predation must be outweighed by nutrient input from the resource being consumed for it to be worth the risk. The question explored in this experiment is how foraging of Western gray squirrels (Sciurias griseus) varies in human-dense environments compared to environments with less-dense human habitats. Each environment requires different energy allocation of the squirrels, and optimal foraging will be found in the environment where foraging is safer, easier, and patches are highly productive. Urban areas serve for less predation but higher traffic, while rural areas

can more comfortably and efficiently forage. This experiment will test species diversity of plants based upon the surface on which they live. The question addressed in this experiment is, is there a difference in plant diversity between plants on flat surfaces and plants on slopes within the same habitat? The data was collected by counting the number of species of plants within a 2 ft² quadrat of fifteen times on both sloped and flat surfaces within the same habitat. Results indicated no statistically significant difference between these two aspects (p=0.223). This pattern may be due to the ability of plants in this area to flourish equally well on both flat and sloped surfaces. The results are important because it provides more knowledge about plant diversity on different surfaces and leaves room for more questions and possible experimentation.

**L-37**  
**Comparison of Stomatal Density of Plants in Natural and Urban Environment**  
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Stomata are small pores that are able to control the exchange of gas in vascular plants, which makes them highly important in letting in CO₂ for carbon fixation and also to control the rate of water. But in order to photosynthesize a plant functionally, it would need a certain range of heat to function. However, researchers suggests that excess amount of heat can cause disturbance of the function because it can lead to dryness. We were interested in comparing amount of stomatal densities of plants in its natural and urban environment to see which has better photosynthesis. Our null hypothesis (H₀) implies that plants in natural (Upper Bidwell) environment would have higher stomata density than in urban (Downtown) one because Carbon dioxide is used more in exchanging with the plants due to the heat of sunlight. In contrast, the alternate hypothesis (H₁) was that plants established on natural environment has less stomata density than in an urban environment because heat led to desiccation of the plant by excessing water evaporation. We gathered a leaf from a particular plant in each environment and observed the stomatal density through a 400x microscope. In addition, we used a two-sample assuming unequal variance test in comparing them and found out that the average of stomatal density in Upper Bidwell is higher than in the downtown leaves, which supports our H₀. Further studies need to be addressed in accumuluating volume of water that plants receive and other factors.
such as pollution must be looked into in terms of exchanging gases with vascular plant.

L-38
The Growth rates of Cilantro in Organic vs Inorganic Soil
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Organic produce has been increasing in popularity over the past 20 years. Because of this, we wanted to test organic versus inorganic soils to note the differences. We hypothesize that by putting the same type of seeds (cilantro seeds) in different soils (organic vs inorganic) the seeds in inorganic soil will grow faster, because there are more readily available nutrients. We used organic and inorganic soil, and used a total of nine seeds to plant in each soil. Starting with data from day 3, when the plants germinated. The average growth of the plants in organic soil on days 3-5 respectively were; 0.7cm, 1.6cm, and 3.07cm. The average growth for plants in inorganic soil on days 3-5 respectively were; 0.9666cm, 1.4cm, and 2.325cm. The P values for days 3-5 respectively were; 0.568283, 0.688646, and 0.096448. From our results, we concluded that the different soils did not create a difference in height. In the future we plan on testing with a larger amount of plant samples over a longer period of time, as well as the plant soil to see if there is a difference in concentration of nutrients and how it can affect plant growth.

L-39
Height of Leaves does not Determine Stomatal Density
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Stomata play a vital role in the exchange of gases as well as in the process of transpiration in trees. Trees are limited in their growth to about 120-130 meters due to the effects of gravity on transpiration. In light of this, we hypothesised that in order to combat the effects of gravity, stomatal density is correlated with leaf height. The stomatal density was measured in three separate locations on leaves taken from a tree from four different heights starting from 0.8 meters from the ground and then every 0.8 meter thereafter. Our experiment produced averages of 50 for 0.8 meters, 38 for 1.6 meters, 51 for 2.4 meters and 43 (400X field size) for 3.2 meters. The results of the difference that the gene, AT3G01190, will code for a protein that will be expressed in the cell wall of the root tip. Using bioinformatic tools on websites such as Genevestigator and TAIR we were able to determine that the last five amino acids of our gene sequence are hydrophilic and that there is no KDEL present at the C-terminus end. We selected our gene using a heat map generated by Genevestigator, by selecting a square that appeared darker in color in the root tip. The darker the square the greater the abundance of mRNA. After selecting our gene we ran multiple Polymerase Chain Reactions (PCR), which were performed to amplify the DNA sequence for gene AT3G01190. Next, the chosen gene, AT3G01190, was cloned and subcloned into plasmids pDONR221 and pMN20GW. Using these plasmids we inoculated Arabidopsis Thaliana, waited until the plant produced seeds and then planted the seeds onto a water agar plate. Once the seeds germinated, the root tips were inspected via fluorescent microscopy to determine if the gene, AT3G01190, was expressed in the cell wall of root tips. After viewing the root tips under the fluorescent microscope, we noticed a distinct difference in fluorescence density between our control root tips and the root tips tagged with yellow fluorescent protein.

UD-9
Ecological facilitation of Blue Oak Trees and Poison Oak in Upper Bidwell Park, CA
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When a plant benefits from another plant, we say there is facilitation present. Our purpose for this study was to determine the presence of facilitation within Blue Oak trees (Quercus douglasii) and Poison Oak plants (Toxicodendron diversilobum) located in Upper Bidwell Park, CA. We hypothesized that Blue Oak trees confer benefits to poison oak abundance, health and size within surrounding areas of these trees. After selecting a number of 30 Blue Oaks we measured and recorded the size and abundance of Poison Oak plants present within a 5 square-meter quadrat. The majority of Blue Oak trees maintained a presence of Poison Oak plants; therefore confirming that there is facilitation present between the two species.
Allelopathy is the feature which some plants exhibit when the excretion of secondary metabolites affects survivorship among interspecific competitors, usually to reduce these traits. *Ailanthus altissima* is an invasive species in which allelopathy is one proposed explanation for its extremely invasive behavior, and enormous success over native plants. Understanding the allelopathic effects of *A. altissima* is necessary to appreciate why it has a competitive advantage over these native plant species. The primary phytotoxic chemical has been shown to be ailanthone, this is the chemical we are testing for in the soil. Soil was collected every meter away from *A. altissima* located along Big Chico Creek on the CSU Chico campus. Garden cress seeds were planted in the collected soil and allowed to germinate. Seeds were also planted in extracted soil the day of, then three and seven days later. Lastly solution was also prepared of dried *A. altissima* to extract the ailanthone, the allelopathic chemical under study. Results indicate that there is a significantly positive relationship (*p* = 0.04) between germination rate and distance from *A. altissima*. Time between extraction and planting showed no effect on seedling germination. In the extraction trial the test group seeds did not germinate after ailanthone exposure. The observed results indicated that *A. altissima* shows allelopathic abilities decreasing vigor of seedlings and preventing seeds from germinating. Ailanthone shows strong capacity to be used as a natural herbicide alternative to traditional synthetic herbicides.

**UD-8**

Transformation and Synthesis of Yellow Fluorescent Protein in Root Tips of *Arabadopsis thailana*

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Does the *Arabadopsis thailana* gene, AT3G01190, code for a protein that is expressed in the cell wall of root tips and does that protein, sequenced by AT3G01190, help in lignin encrustation? We hypothe-

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**L-40**

**Effects of Degree of Perfection on Batesian Mimicry**

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Batesian mimicry is an occurrence in which a harmless species evolves to resemble a toxic or noxious species in order to increase fitness. The effectiveness of Batesian mimicry relies on the degree of distastefulness of the model, the frequency of the mimic, and the degree of perfection of the mimic. Because the degree of perfection relies on the similarity in appearance between the mimic and its model, we were interested in the relationship between degree of perfection and the effectiveness of the mimicry. We hypothesize that the frequency of disappearance at which the mimics that are more perfectly mimicking the models will decrease because the birds will learn to associate the mimics with distastefulness. We added different amounts of color dye (blue) to safflower seeds to create a mimic that perfectly resembled the model and two mimics of differing degrees of darker shades. Over the course of four days, we generated random arrays of seeds with 75% of the population being models and 25% including all of the species of mimics and exposed them to birds for three hours. Chi squared tests resulted in daily p values that were greater than .05, which indicates no correlation between the mimics’ degree of perfection and the predators’ feeding patterns. To improve future tests, training for the birds should be done the week preceding the experiment in order to promote more regular feeding patterns.
L-41
Stomatal Density Varies on Distance from a Viable Water Source
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All vascular plants have stomata; these pores on the leaves of vascular plants regulate carbon dioxide and oxygen exchange as well as water loss. We tested the hypothesis that maple leaves that are located on a tree closer to water would have a higher stomata density than maple leaves on trees further away because the maple leaves closer to a viable water source can possess more stomata to make up for the water loss. We counted the number of stomata under a microscope at a 400x field size, from the leaves of *Acer spcatum*. Stomatal density was recorded on 12 leaves, six from sun and six from shade at 10, 25, 50, 75, 100, and 150 feet from the water source. The leaves in the sun lost 15% of their stomata, and the leaves in the shade lost 20%, between the 10 feet to 150 feet (P<.05) from the water source. This data infers that the distance between the maple trees from a viable water source and stomatal density of the maple leaves have a negative correlation, as the plants are dispersed further away from a viable water source it is beneficial to have less stomata to counteract dehydration. Future tests that can also be tested is if stomata density is controlled more by the environment or by genetics for trees near a viable water source and trees further away.

L-42
Effects of Overcrowding On the Growth of Marigolds
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Some plants can be grown around a plethora of other plants with minimal space, but in this instance we predict that marigold plants that are overcrowded will not grow as well as non-crowded plants. The reason for this is there is not enough room to grow and they have to compete for resources. This experiment was conducted to measure the growth of six marigolds in one 12 in. container (represents non crowded) versus six marigolds in one 6 in. container (represents over-
A Study of Characteristics of Storage Trees Used by Acorn Woodpeckers
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For species that don’t migrate seasonally, storing food for “dry-seasons” is important for continued persistence and survival. Acorn woodpeckers use Valley Oak trees as storage for their main food source—acorns. The goal is to determine what characteristics Acorn Woodpeckers prefer for creating their granaries. The hypothesis is that the woodpeckers will store their acorns in dead trees/branches as it requires less energy from the woodpecker due to the tree’s hollow trunk and weaker exterior. To properly conduct this experiment, the lab manual states that a 500 meter transect be used as a path to collect data on the characteristics of the granary trees and the Acorn Woodpeckers’ food storage habits. The results show that the acorn woodpeckers have a strong preference toward storing their acorns in dead Valley Oak Trees. This provides information regarding the acorn woodpeckers’ optimal foraging habits which are significant because unlike most birds, they store their food instead of migrate during the off-season. Understanding the type of habitat they need to survive and thrive within will help efforts in regards to the increase and rehabilitation of their population. Having this data will help to determine the woodpecker’s habitat, along with their environmental impact and disturbance to surrounding species and populations.

Decomposition Rates of Woody Plant Foliage
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Leaf decomposition in freshwater streams is an important part of nutrient cycling, which can influence the stream’s productivity. The rate of decomposition is reliant upon several factors including the amount of sclerophyllous tissue within the leaves. To distinguish decomposition rates in local freshwater of three differing species, Camellias (Camellia sp.), Maple (Acer sp.), Valley Oak (Quercus lobata), over a four week period. Leaves from each species were harvested on California State University, Chico’s campus and then submerged into Big crowded). Water was evenly distributed with one cup of water in each container after the first inch of topsoil is dry. Plants were measured in inches five times throughout the duration from the soil to the top of the tallest flower per plant. At the last day (day 16) of measurement, the average of the plants in the non-crowded is 5.52in. and the average for the crowded container is 5.1 in. (P=0.12, df=5, and t=2.02). In a future experiment, the plant growth could be simulated with different degrees of crowding to see the full effect of crowding in comparison to the two degrees presented in this experiment.

Stomata density of Periwinkle leaves varies based on moisture content in the soil
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Stomata are an opening that allows for water to exit the leaf to cause a negative pressure in the leaf to cause transpiration. Stomata density can be affected by a variety of environmental cues which can help prevent water loss. Due to transpiration, a plant far away from a water source, such as a creek, will have more stomata density in order to cycle water through its system. We tested this by obtaining 5 leaves from a plant right next to a creek and a plant 200 feet from the same creek. Our results showed that the plant closest to the creek had an average stomata density of 25.6, and the plant further away had a stomata density of 38.0 (P-value= 0.01). The plants closer to the water can easily obtain water from its moist soil, whereas plants further away from a major water source needs to take up as much water as it can from the soil by causing a negative pressure in the leaf through transpiration which will help the plant uptake as much available water as possible. In future we can test if the stomata stay open the entire day or if they are only open for parts of the day.
Upper Division Class Projects

UD-1
Climate Conditions Change Migration Patterns
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California’s drought and irregular weather patterns have influenced the amount of water available throughout the state, especially in conservation areas which are also experiencing a 25% cut of allocated water. Waterfowl following the pacific flyway traditionally winter in the northern central valley then move northeast for breeding grounds. However with irregular rainfall and timing of the precipitation, waterfowl will need to migrate earlier in search of food. This experiment tested the hypothesis which waterfowl species richness would be different at Ash Creek and Llano Seco wildlife areas based on waterfowl being sampling specialists. Ash Creek wildlife refuge resides in the northeastern section of California, which is traditional a breeding grounds for waterfowl. The 2014 winter and 2015 spring has brought unusual precipitation, the valley has experience little rain in the late winter and early spring, whereas northeastern CA has been receiving regular amount of rain along with ponds being filled by snow melt. In determining species richness, eight points of observation were selected per site, each breed was identified and population numbers were recorded. Due to the available food and ideal breeding ground conditions for the waterfowl, the Ash Creek wildlife area has a significantly higher species diversity over Llano Seco (p=.000296). The data collected in this experiment is significant in noting that waterfowl migration has been affected by the changing climate conditions and lack of precipitation. Waterfowl are adaptable to changing climate conditions proving they are sampling specialists, and will select habitat areas based on the available resources.

UD-2
Interspecific Exploitation of Western Grey Squirrels and California Ground Squirrels Seen while Stealing Acorns from Acorn Woodpeckers
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Ecological communities and populations are influenced by different types of competition. Interspecific competition is when two different species compete for the same resource. In some cases, one species will out compete the other for the same resource, this is known as exploitative competition. One example of this is robbing, where squirrels steal food from other species when possible. This relates to Optimal Foraging Theory, since both time and energy are saved. Species waste energy to receive energy such as food, therefore, it is more advantageous for species to lower its energy cost. One way to reduce energy expended is to steal from other species. The hypothesis of this experiment is that Western Grey Squirrels display more exploitative competition than ground squirrels when stealing from acorn woodpecker granaries because ground squirrels prefer to gather their food on the ground. Calculating exploitative competition was performed by tallying up raids per hour for each species of squirrel once a day for ten days in an oak woodland habitat in Chico, CA. Results indicated that grey squirrels out compete ground squirrels (p = 0.00).

UD-3
Number of Granaries in Valley Oaks Correlates to Tree Size
Jennifer Alvarez, Alyssa Bowlsby, Brendan Tinsley, and Alexa Woodward

Acorn Woodpeckers (Melanerpes formicivorus) are common to the California riparian habitat. They are known to store acorns in a variety of tree species including valley oaks (Quercus lobata). This study sought to determine acorn woodpeckers’ preferences for older trees as approximated by tree size. The trees sampled (n=25) included only valley oak trees on the southeast side of Sycamore Pool in Bidwell Park. Digital images of the granaries were taken and the holes made by the acorn woodpeckers were counted. Trees were then compared and grouped based on the diameter at breast height (dbh) and the approximate number of holes present. The data indicated that acorn woodpeckers preferentially chose valley oaks with larger diameters (p-value = 0.027). The tree diameter correlates with the age of the tree, and further research could assess why older valley oaks are preferable for being used as granaries.