16th Annual
Student Research
Poster Symposium

May 11th, 2012
1pm – 4pm
Holt Hall

Department of Biological Sciences
California State University, Chico
POSTERS

LOWER DIVISION CLASSES
Holt 225 and 235

UPPER DIVISION CLASSES,
UNDERGRADUATE RESEARCH
Holt 227

GRADUATE CLASSES,
THESIS RESEARCH
Holt 251

ENTOMOLOGY CLASS DISPLAY
Holt 235

ORNITHOLOGY DISPLAY
Holt 235

GREENHOUSES OPEN TO VIEW
10 am – 3 pm
Tom Rodgers
Outstanding
Researcher Award

Recipients:

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 Daniele
Recipients:

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

2009 - Amir Bagheri, Broderick Illa, Crissy Nelson, and Danny Weller

2009 - Jonathon Schneider, Jordanna Forman, Justin Peek, and Katie Collins

2009 - Lee Ho, Lisa North, Meghann Shorrock, and Reid Griggs

2009 - Robert Marvin, Sanae Burries, Vanessa Cox, and Zaira Jimenez

2010 - Melissa Maney

2011 - Ellie Oliver and Juan Mota
Lower Division Class Projects

**LD -1**

**Fire Ecology: Measurement of Protein Content on Black Tailed Deer Forage in Burned and Unburned Sites from the Big Chico Creek Reserve**

Connie Acosta, Courtney Henry and Martha Montez  
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Many plant species in fire affected environments actually require fire to germinate and prosper. The avoidance of fire can lead to a buildup of inflammable plants which can lead to more destructive fires. Controlled burning is a tool for scientists and foresters to obtain information on soil, nutrients of plant life, and limit uncontrolled fires. This study focused on deer forage on controlled- burn and un-controlled burn environments. Protein extractions from burned and unburned sites located in the Big Chico Creek Reserve (BCCR) were used to decipher the nutrient content based on protein between the two sites. The plants used for extraction from each site were Iris psuedacorus, Chlorogalum pomeridianum, Erodium botrys, and Ceanothus integerrimus. The purpose of this study was to isolate how much protein is was present in four different types of plants (deer forage) and compare burned and unburned site’s protein content. A protein extraction was conducted from each plant sample at each site. Our statistical analysis includes one replication (site), two treatments (burned and unburned), & four plant species.

**LD -2**

**Varying levels of carbon dioxide and its effect on *Raphanus sativus* biomass.**

Habib al Saffar and Chris Chambers  
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Increasing levels of carbon dioxide has many effects on the planets ecosystem. One important area of research deals with plant biomass and varying levels of carbon dioxide. We analyzed the effects of increasing levels of CO$_2$ on the radish plant (*Raphanus sativus*). We had a group of radishes that received higher levels of CO$_2$ and a control group that experienced atmospheric levels. We learned through statistical analysis that the increased levels of CO$_2$ did have an effect on the plant’s biomass. The group receiving higher levels of CO$_2$ had an average weight of 6.2 grams; whereas the group with atmospheric levels had an average of 3.9 grams. The calculated t-test equaled 3.65, and at 10 degrees of freedom the t-score is at 2.23. We could say with 95% confidence that our null hypothesis was rejected. We can see that increasing levels of carbon dioxide does have an effect on plant biomass. Our null hypothesis was rejected.

**LD -3**

**Phenotypic Plasticity Among Stomatal Density in Blue Oaks in Relation to Distance from Big Chico Creek**

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The goal of this experiment is to study the phenotypic plasticity of stomatal density among the Blue Oak tree species in response to the tree species distance to an observable source of running water (Big Chico Creek). This experiment is based on obtaining the stomatal density from leaves taken from nine different trees set in three groups (three trees in each group) upon
their distance from the creek. The first set of trees was collected ~10 meters from the creek, the second set was ~50-60 meters from the creek and the third set was ~100-110 meters from the creek. The data (once obtained) will be analyzed by comparing means through an ANOVA test. The expected outcome based on the hypothesis is that the trees that are closest to the creek will have the highest stomatal density.

LD -4
Cigarette Smoke’s Impact on the Development of Impatiens walleriana and Portulaca
Thomas Allen, Kevin Deidrick and Aleksander Fornalski
BIOL 152: Christopher Ivey civey@csuchico.edu, Darhl Whitlock dwhitlock@csuchico.edu

Years of clinical studies have conclusively linked cigarette smoke, both primary and secondary, to heart and lung disease and widely varied cancers. Questions remain, however, regarding the impact of cigarette smoke on plants. Whether house plants suffer from living with smokers is a relevant concern. According to the Lung Association, tobacco smoke contains more than 4000 chemicals, many of them poisonous or carcinogenic. In our study, we chose to look at the effect cigarette smoke could have on plants. Our hypothesis was that cigarette smoke would negatively affect a plant’s successful flower production, and overall fitness. We tested this hypothesis by exposing two different species of plant, Impatiens walleriana and Portulaca Tequila Mix, to cigarette smoke multiple times a day over a period of a few weeks. To quantify a potential effect, we counted each plant’s flower number. Additionally, we calculated a ratio of buds to flowers to see how effectively each plant produced its flowers. Our data supported our hypothesis in that both species of plant exposed to the cigarette smoke took longer to flower, as well as producing lower quality flowers and leaves.

LD -5
A Comparative Study: Organic snail pesticide and chemical bait tested on Magnolia reveals no significant difference
Brenda Avalos, Charlie Cimmarusti, Garrett Haffey, & Heather Lawther
BIOL 152: Christopher Ivey civey@csuchico.edu, Darhl Whitlock dwhitlock@csuchico.edu

The typical snail bait purchased in stores is poisonous to all animals including pets, or will contaminate water sources. There are many alternatives suggested varying from beer, to simply collecting the snails when they are active at night. The main problem under investigation was if an organic home-made pesticide worked just as effective as poisonous bait. A mixture of peppers and garlic made into a spray was chosen to test its effectiveness compared to store bought snail bait. The study was conducted by setting up three sections of plants, the first was the control, second was snail bait added, and third was the plants sprayed. Snails were subjected to each section and at the end of the week the average amount of plant damaged was measured. Results yielded an average of 34.81 percent damaged with a deviation of 13.56 for snail bait and 35.98 percent damaged with a deviation of 7.60 for the spray. An ANOVA test was done and calculated a 0.18 difference with a degree of freedom of 10 showed that there was no significant difference between the two pesticides. The test concluded that the alternative organic pesticide is just as effective as the poisonous snail bait in protecting plants from snail predation as well as being less costly.
**Effects of Agriculture on Invertebrate Species Diversity**

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The objective of this experiment is to compare insect diversity between a natural, unaltered environment and human altered agriculture environment. Our goal was to see if agriculture practices impact species diversity. Our natural site was the Big Chico Creek Ecological Reserve, and we chose a Chico area almond orchard as our agriculture site. Twenty five pit traps were installed at each site to capture invertebrates. After one week the traps were collected and the invertebrates were identified to order. The Big Chico Creek Ecological Reserve had nine orders with 224 individuals. The almond orchard had six orders and 65 individuals. Both richness and evenness were taken to account and calculated using a Shannon index. Both site Shannon Diversity index was 1.4. The Big Chico Creek Ecological Reserve had a higher species richness and diversity due to its higher number of orders and individuals. However they both have an equal distribution of species richness and evenness. The Shannon index may have not been a good indicator for this experiment.

**Optimal Foraging Theory and Risk Factor with Northern California Birds**

Matt Bancroft, Barrett Hollingsworth, Kelsey Hughes and Kim Lindsey

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The purpose for this project was to scientifically study optimal foraging theory and risk factors. Our team studied the risk Northern California birds would take to obtain higher calorie food. Higher and lower calorie seeds were strategically placed with one bowl of each treatment placed lower to the ground (higher risk) and the other two types of treatment bowls of seeds placed higher from the ground (lower risk). Under investigation was if the birds would eat high risk, high calorie before low risk, low calorie seeds. The results were calculated after a week of collecting foraging data. We found that on average the birds ate 6.74 (+/- 3.88) grams of high risk, high calorie. The high risk, low calorie seeds averaged 10.19 (+/- 0.04) grams a day. On the contrary, low risk high calorie was 3.76 (+/- 4.09) grams and low risk; low calorie was 9.58 (+/- 1.46) grams. We calculated a chi square value of 136 (3 degrees of freedom), and a P-value of 0.0001. By conventional criteria, the difference was considered to be statistically significant. The broader biological principle findings from this investigation were that birds were willing to be at risk for higher calorie foods.

**Foraging Behavior of Squirrels**

Morgan Beentjes, Angie Notari and Nicole Stone

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Today the human population is exponentially growing and to keep up with the pace, development of land is constantly taking place in areas that were once untouched by mankind. With this constant expansion, human interference is most likely to occur between humans and the local species in the areas of development. This experiment was conducted to test whether squirrels located on or near the Chico State campus have a preferred location to forage their food. The two factors that were tested and compared in order to examine this inquiry were human traffic and food coverage. To do this two trays of 200 peanuts were placed in four separate locations on campus for five days.
consecutively. Two of the locations were placed in areas with a heavy flow of human traffic, one of which had sufficient tree or bush coverage, the other with none. Two other trays were placed in more undisturbed, remote areas, again one with coverage and one without.

LD -9
The effect of shade and sunlight on stomatal density
Sean Bentinck, Taylor Herren and Ethan McEnroe
BIOL 152: Christopher Ivey civey@csuchico.edu, Darhl Whitlock dwhitlock@csuchico.edu

As primary producers plants are an essential component of every ecosystem. It is important that we as scientists, understand the relationship between plants and certain environmental conditions. The environmental condition of interest is degree of sunlight and whether it affects the stomata per micrometer on the ventral side of the leaf. In an experiment carried out on the CSUC campus a plant that was exposed to varying amounts of sunlight was used to test the hypothesis of whether degree of sunlight affected stomatal density. Leaves were selected from areas of the plant that were heavily exposed to sunlight as well as areas covered by shade. The number of stomata per 14um per leaf was measured and compared. The results showed that there was an average of 351 stomata per unit area on the sunlight plants and 327 stomata per unit area on the shade plants. Although the difference appears minimal, the p-value was less than 0.05 signifying that the results are statistically significant and we can reject the null hypothesis. The concentration of stomata of leaves exposed to direct sunlight was 7.31% higher than the stomatal density of the leaves in shade (t =10.86 df=38 P< 0.05). This experiment proved to be biologically significant because it supports the theory that a plant will grow in a way to receive the optimal amount of sun exposure, which consequently increases the concentration of stomata and maximizes the plants control over gas exchange.

LD -10
Effects of simulated acid rain on growth rates of Brassica rapa
Casey Camilleri, Sundeep Lally, Sarah Jones, Marissa Brown
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One of many environmental concerns surrounding our world today involves the increasing acidity of our rainfall (Shevtsova and Neuvonen 1997). The lowest recorded pH level in the United States by the Environmental Protection Agency is 4.3. The purpose of this experiment was to compare the effects of acidity on the growth of Brassica rapa using lemon juice (pH 2) and water (pH 7 – “neutral”) (McMurry and Fay 2008). The acidic soil had a measured pH of 3 and the water-treated soil had a measured pH of 6. We hypothesized the B. rapa plants would experience negative growth in both height and leaf diameter (at the widest point) in the more acidic soil. For this experiment, 18 trials were used for each treatment. The B. rapa seeds were allowed to grow to maturity. The control group received soil treated only with water and no additional pH adjustments. The test group received soil treated with lemon juice. After two weeks (expected time to plant maturity), the heights and leaf diameter were measured. The expected overall growth rate of the plants in acidic soil is substantially lower than the plants with the more alkaline soil. With 17 degrees of freedom and a p-value of .05, our t value of --- allows us to reject our null hypothesis with 95% confidence. These results suggest that plants grow less efficiently under acidic conditions than under conditions where the soil is able to maintain a more neutral environment.

LD -11
Testing of Mimicry amongst *Brassica rapa* and Predators *Piereris rapae* in a controlled environment

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In this experiment, we were motivated to see how mimicry would play a role in feeding habits of the caterpillar *Piereris rapa*. This project can relate with others in that we are testing the natural role of mimicry on a species and seeing how it affects a predator's behavior. We have the problem of trying to understand how mimicry would affect our caterpillars’ diets and to see if it affected the amount of biomass they consumed. To conduct this study, we gathered 3 caterpillars, *Piereris rapae*, for each of the three sets of *Brassica rapa* and study their eating behaviors. We provided a control, which was just a regular *Brassica rapa*, and two other sets each with a different amount of Angelica root extract; one has 1/3 of its surface area painted on while the other has 2/3 of its surface area painted on.

From our results, we saw that the caterpillars tended to eat more biomass of the controlled *Brassica rapa* due to not having and deterrents of Angelica root extract. We can conclude that our mimicry implemented on the *Brassica rapa* helped their survival amongst the rest of their species when being predated by the *Piereris rapae*.

LD -12
Effects of Overcrowding on Germination Height and total Biomass of Comet and D'Avignon radishes

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Overcrowding of plants has been known to decrease the productivity and growth of plants. This project focuses on the effects of overcrowding on germination height and overall biomass. This project used two different types of radishes the Comet and D'Avignon. Individual growth pots are filled with one of four treatments, 3 seeds, 5 seeds, 7 seeds, or 10 seeds. More seeds planted in a contained area would have a decrease in biomass and height. Overcrowding a plot of plants can decrease total yield as well as damage growth. Total biomass for both the Comet and D'Avignon showed significant difference in the average of total biomass as well as height (p-value<.05). This shows that there is a significant difference on the numbers of seeds planted on total biomass and germination height.

LD -13
Comparison of species richness at high and low light exposures in Upper Bidwell Park

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Species richness is determined by many variables such as disturbance, resource availability, competition, area, and canopy cover. Our question wishes to analyze how species richness changes in response to low (shade) and high (sun) light exposures. We hypothesized that there was more richness under the high exposure because of its increased light availability. We tested our hypothesis at Bidwell Park specifically in Upper Bidwell. In the end we concluded that there was more richness in areas with higher sun exposure. The sun provides a major factor that is significant to the species
richness. It provides nutrients to regulate photosynthesis. Photosynthesis absorbs CO2, water, and sunlight, which produce O2 and Carbohydrates which human benefit from.

LD -14
Optimal Foraging Behavior of Honeybees on Spanish Lavendar- \textit{(Lavandula stoechas)}
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Animals are expected to express optimal foraging in order to survive. Pollinators, such as honeybees, express optimal foraging and are easily observable. We followed up on Robert H. MacAuthor and Eric R. Pianka’s experiment in their study of foraging behavior of honeybees in a patchy environment. We focused on honeybees foraging \textit{Lavandula stoechas} and studied their behavior. We tested the hypothesis that honeybees can sense variation in their environment and will spend more handling time on patches of flowers that are more energetically rewarding. We followed honeybees foraging \textit{Lavandula stoechas} to observe how often they visited flower patches that were uncovered and previously covered in a certain period of time. The honeybees foraged an average of 5.2 ± 1.3 uncovered flowers per minute while they foraged an average of 3.20 ± 0.90 previously covered flowers per minute (T=8.46, d.f=87, P= 0.05). We found that honeybees expressed behavior plasticity in their foraging behavior when presented with a patch of previously covered \textit{Lavandula stoechas} with a higher density of nectar. These results support our hypothesis that honeybees will adjust their foraging behavior and spend more handling time on foraging on a plant that will maximize their energy intake.

LD -15
Stomatal density of Manzanita directly correlated to elevation
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There have been few experiments testing stomatal density in relation to elevation. Most experiments testing the concentration of CO2 have been done artificially. Our motivation for this project came from the lack of experiments testing the relationship between elevation and stomatal density and our curiosity about whether there was a significant difference in our local area. We hypothesized that leaves from the Manzanita in Cohasset, CA, which are at a higher elevation, would have more stomata than those leaves in Upper Bidwell Park. In contrast to our hypothesis results indicate that lower elevations have higher stomatal densities than higher elevation sites for manzitanitas (p-value = 1.02x10^{-7}). We believe this can be attributed the fact that the stomata were larger in diameter in higher elevation, and smaller in lower elevations. Therefore each stomata takes up more space on the underside of the leaf, so although the density is lower they are still able to intake the same amount of gases. This increase in size could possibly be directly correlated to the lack of gases in higher elevation compared to lower elevation. In conclusion although our original prediction was incorrect, we still found significant difference in our data, and leaned that there is a correlation between stomatal density and elevation of the Manzanita.
The Effects of Cigarette Ash on the Germination of Lettuce Plants
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Nationally there are approximately 47 million cigarette smokers and cigarette butts account for one-quarter or more of the items tossed onto streets and other roadways (Kaufman, 2009). Improper cigarette and ash disposal is not only aesthetically unpleasing but may have an adverse effect on the environment. We hypothesized that the cigarette ash is harmful to the germination of lettuce plants because of the ingredients in the cigarette itself (i.e.; nicotine, formaldehyde, acetone, methanol, etc.) Throughout the month, we weighed the cigarette ashes and added the same amount [275 mg] every third day to thirty lettuce plants while leaving the other thirty alone. During this time, we monitored their growth and recorded results. We did not alter the watering times, amounts of water, or the amount of sunlight each of the sixty plants received. Consistent with the hypothesis, the plants that were fertilized with the cigarette ash germinated at a slower rate than the control group with an average height difference of 1.5cm (t-test=5.991, df=28, p > 0.05).

TITLE
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Based on Gause’s 1932 competitive exclusion principal two species cannot coexist on the same limiting resource. For competing species to coexist, they must do so through nitch differentiation. The Acorn Woodpecker (*Melanerpes formicirorus*) has a very distinct behavior to the other birds in oak woodlands of Chico, CA. The *Melanerpes formicirorus* social system, displays aggressive behavior when groupings are upholding a territory. In the Chico area, nitch partitioning does not pertain to the Acorn woodpecker, because of their highly competitive behavior and dominance. When observing the number of other birds in a tree in oak woodland habitat of the acorn woodpecker, there was significant results that depicted the more Acorn woodpeckers in a tree, the less there was of other birds. As there are many other birds in the Chico area that have the same food source that includes, acorns, insects, sap, and fruit; In the famous 1960’s study of nitch partitioning evaluated by MacArthur concluded that natural selection will drive two species that compete for the same food source will result in a resource change. To avoid competition and to reserve energy the two species will occupy different sections of the habitat and thus form separate nitches. This is not seen here in Chico. It is simply the aggressive behavior of the Acorn woodpecker that is driving other species of birds to inhabit another tree in the same woodland, not of a different food source.

Red Wrigglers and Nightcrawlers Effect on Radish Plant Development
Matt Hartman and Andrew Lerner
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The hypothesis tested was that Red Wrigglers, a popular composting worm, will have a greater beneficial effect on radish plant development resulting in taller pants with more leaves than the Nightcrawler species. Three soil beds were created that began which the same soil composition and equal number of radish seeds. Initially each of the three soil beds were set up to contain one of the following: 30 Red Wrigglers, 30 Nightcrawlers, or no worms. All three beds were kept indoors and the
amount of water and light were controlled. After 14 days plants were collected and measured for height of stem above soil and total number of leaves. The results of an Anova indicated a significant difference in number of leaves in plants of soil bed containing Red Wrigglers compared to both Nightcrawler and control soil beds. However no significant difference was found between plant heights.

LD -19

Foraging preference of *Apis mellifera* on floral scent and color and its implications for evolutionary selection in flowering plants
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Foraging preference of *Apis mellifera* on floral scent and color and its implications for evolutionary selection in flowering plants

LD -20

Foraging Behavior Response of Bees to Varied Resource Availability
Chris Kaiakapu ckaikapu@mail.csuchico.edu, Kasaundra Jones kjones60@mail.csuchico.edu, Jackson Price jprice13@mail.csuchico.edu

Optimal foraging strategy is a key component in the animal kingdom which acts to maximize an individual's rate of energy intake. Pollinators have been a keystone species in evaluating foraging ecology due to the ease of observation. Studying foraging strategy can contribute to understanding other behaviors such as habitat selection, diet, and predator/prey interactions. The present question is whether honey-bees will forage with behavioral plasticity and express the ability to adapt to environmental changes. The scientific hypothesis for this study suggests that when a pollinator’s primary resource becomes less available, they will adjust their foraging behavior to exploit more available resources. In order to test this theory, a portion of resource plants are manipulated to increase nectar and thus resource availability. Comparing measurements of nectar, amount of bees visited, and handling time, of both control and manipulated resources, allow behavioral changes to be distinguished. Alternative outcomes of foraging studies is one where there is no difference in foraging behavior due to either a limited learning capacity or insufficient observation interval. Plants under observation in this experiment include rosemary(on-campus) and lavender(off-campus), both of which attract sufficient pollinators to be considered a primary resource, a crucial step when conducting a study of foraging ecology. The data describes average handling time and foraging rate, expressed as millimeters of nectar harvested per minute. Expected results of the study fall within
optimal foraging and behavioral plasticity theories; bees alter their behavior to exploit the greater abundances of nectar produced by manipulated plants.

LD -21
A plant survey of Himalayan blackberry (Rubus armeniacus) and California blackberry (Rubus ursinus) in Lower Bidwell Park
Nika Melero and Zack Jannings
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We surveyed the number of native California Blackberry in lower Bidwell Park. The significance of the project is to determine if the growth of the Himalayan blackberry will decrease the number of native California blackberry. The concentrations of the native species were different where Himalayan blackberry were present and absent. One hypothesis is the number of native blackberry will not be different when Himalayan blackberry are present. We hypothesize the areas absent of the Himalayan blackberry will have a significantly high number of California blackberry. The methods to support the hypotheses were measurements of the number of blackberry species in eight areas. The areas measured were six square feet and the blackberry species counted were the Himalayan and California. Based on our results we found that when Himalayan blackberry species are present the amount of native species drastically reduced. Our data showed that when Himalayan blackberry were present, they had an average of 16 plants within the area measured. With this being said, the California blackberry had a lower average with 11 plants. Our T-test calculations came out to 3.89 with degrees of freedom of 219, and a p-value of .05. so we could reject our null hypothesis.

LD -22
Food foraging choices for Black Carpenter Ants (Camponotus pennsylvanicus) Sugary, Salty or Protein?
Rebecka Miller and Monet Filteau
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Due to curiosity of specific selection of food sources among black carpenter ants (Camponotus pennsylvanicus), this study was done to determine the preferred food source. The question under investigation is what source of food do black ants prefer to eat (sugary, salty or protein)? The hypothesis states that the black ants will prefer a sugary source of food more than salty or protein source. This hypothesis was tested over a period of 3 days. A specific location on the campus of Chico State, with tall grass was used for data collection. Three petri dishes were set out each day. Each dish contained a different source of food for the ants to select. The three sources were 10 grams of strawberries, kettle chips, and boiled chicken. The data collected was the number of ants trapped in the petri dishes. With this number, the statistical analysis used was ANOVA. The p-value calculated in the experiment is 0.004. When comparing to the p-value of 0.05, the results determine significant data. The degrees of freedom calculated in the experiment are 2. Therefore, the preference of food choice for the black ants was not equal. The overall food source preferred was the salty kettle chips.
**LD -23**

**The potential effect of grassland fires on plant diversity**

Lilly Moghadam, Erika Kalmar, Jacob Stroman and Kohner Vugrenes  
BIOL 152: Christopher Ivey civey@csuchico.edu, Darhl Whitlock dwhitlock@csuchico.edu

Fire can play a large role in the success of plant survival and seed dispersal; it may also cause detrimental effects. Frequent yearly controlled burns could account for the success of grassland populations in richness and evenness. We tested the hypothesis that burned areas of the Butte Creek flood plain would yield greater species diversity and greater plant populations, whereas unburned areas would yield less biodiversity and smaller plant populations. According to the Shannon Diversity index the burned areas had greater species richness, and greater evenness. The results from the T-test proved that there was no significant difference between the burned and un-burned plots. We found that there was a difference in plant diversity, but none that was statistically significant. The areas that were surveyed as being burned had undergone a controlled burn approximately a year before we surveyed, and boasted larger populations of plants, but had no significant difference in diversity. This study could give further understanding to the role of natural yearly grassland fires and their necessity for plant populations and diversity.

**LD -24**

**The Potential Use of Urine as a Growth Catalyst for Plants**

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Urine is a byproduct of the animal excretory system. The technical term is micturition, which is Latin for “micturi” which literally means to desire to urinate. Everyone does it, everyday, but how often do we think about what urine actually is? What it’s composed of? Perhaps even how other organisms could utilize urine for their benefit? People often think that urine is a great source of nitrogen, therefore attempting to utilize urine in the garden as a catalyst for plant growth. However, upon closer investigation, I have discovered that this common practice may in fact have the inverse effect. Through careful procedures and close observation, I have found that if not executed properly, the use of urine as a growth catalyst in plants may cause cellular damage possibly even death. I conducted a study of 150 pods each containing 3 seeds, 50 pods treated with a water-urine ratio, 50 pods treated only with water, and 50 pods treated only with urine. The plant seed of choice was the Cherry Belle Radish (Raphanus sativus), selected for its rapid 3-5 day germination rate. Wood ash was placed on top of the soil as a carbon filter. After two weeks of incubation the 150 seeds that were treated with only urine showed no sign of germination. The 150 seeds that were treated with a urine-water ratio showed only a few slight soil ruptures but no above-ground growth. Lastly, the 50 seeds treated only with water demonstrated strong above-ground growth and are currently continuing to grow. Due to these results, I have concluded that the use of urine as a growth-catalyst in plants is a very delicate process and should be executed only after proper precautions are taken. The urine-water ratio is very important and the presence of water is absolutely necessary for growth success.

**LD -25**

**Ecological analysis of richness across a disturbance gradient**

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Disturbances in a community can cause negative impediment to the biodiversity of the corresponding ecosystem. This problem implies that to better understand the causes of species diversity; we must first properly define disturbances if we hope to test them for statistical significance. In order to address this problem, repetitive gradient analyses must be conducted in varying ecosystem communities. We chose to conduct an Ecological Gradient Analysis within 5-Mile Recreation Area located within Bidwell Park in order to observe the effects of human disturbance as a function of three locations: an Island, Creek Bank, and Upland (respectively representing low, intermediate, and high disturbance regions). Upon leaving rudimentary pitfall traps out for 3 days, identification of orders observed as well as calculation of the Shannon Index of Diversity and statistical analyses aided to reveal a significant relationship. A mean SDI, or Shannon Diversity Index, of 1.76 (n = 27), for the Creek Bank condition indicated significantly more species diversity than the Island (SDI = 1.28, n = 7), and Upland (SDI = 1.44, n = 19) regions. (P = 0.0023, df = 2, F = 10.51). These results suggest that intermediate disturbance may be a necessary, or at least highly beneficial condition to maintaining high amounts of biodiversity within a community.

LD -26
Stomatal Density of Rubus ursinus with Varying Access to Water
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This experiment was conducted to understand the impact that varying environments have on the phenotypic plasticity of the native Delairea odorata, commonly known as the cape ivy. We researched these impacts by measuring the varying stomatal density of Delairea odorata at different areas in Bidwell Park: areas close to the river, areas away from the river and heavily shaded regions. The developmental change of stomatal density is likely caused by environmental cues in the surrounding area, so overall, we are looking to find if resources in the environment or the amount of readily available resources can have an affect on the plant phenotypically. By taking leaf samples from multiple environments within the same area and comparing their stomatal density, we can determine if there is a significant difference in stomatal densities when faced with different selection pressures. From there, we can better understand how the environmental cues of Bidwell Park can have an effect on the stomatal density of local cape ivy plants. Such changes due to these environmental cues would be a prime example of phenotypic plasticity. Our experimental hypothesis was that plants that were collected further away from the water would have a lower stomatal density due to the need to conserve water. We will apply our data in an ANOVA statistical test to statistically support or reject our hypothesis. Results for our study are pending. If our hypothesis is supported by our statistical results we will be able to conclude the access to water does have a significance on the stomatal density of Delairea odorata and therefore supports the concept of adaptations through phenotypic plasticity by plant species.

LD -27
How Water Contributes to Oak Apple Gall Density
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The formation of oak galls is a natural response to when wasp larva are laid into the bark of the tree, the formation of these galls prevents further damage to the tree and a stable environment for the wasp larva; they also provide shelter to numerous other species helping keep a diverse species
system. The main point of this experiment is to find any statistical connection between oak gall density and water source proximity. To do this our group collected data from areas of Upper and Lower Bidwell Park, measuring out quadrants adjacent to and a longer distance from a water source. Results indicated that there was no difference in oak gall density and proximity to a water source (p-value = 0.906). Our findings did not support there being a relationship between water proximity and gall density this is possibly due to the fact that wasps may prefer to lay eggs in trees with preestablished galls. A later experiment with a more stable, controlled grove of oak trees would help further develop any patterns of gall density.

LD -28
Density-Dependent Growth in *Brassica rapa*
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Density dependent relationships exist among many organisms in nature. In this experiment the effect of inter species density was tested on *Brassica rapa*. The goal of this experiment was to test the most productive environment for *B. rapa* to grow based on the population density. The density versus productivity curve illustrates at what density a species is optimally productive. Multiple cells were set up with varying number of *B. rapa* seeds. Six environments with ranging densities of one to sixteen seeds were replicated four times. Environments with one seed were considered the control groups. Seeds were allowed to grow for 14 days and productivity was measured by the height of each plant as well as the number of flowers produced. Our expected results are maximum productivity at an intermediate density and decreased productivity with the extremely low or high densities. Decreased productivity would include shorter plants and less fitness, or flowering.

LD -29
Foraging Ecology in Rural and Urban Settings
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The idea of this experiment was to test the concept of optimal foraging from the study of ecology. Optimal foraging is the expectation that animal behavior is expected to evolve to most efficiently harvest energy from the environment. We are testing if squirrels would find it easier to forge for food in a rural or urban setting. We placed a single uncovered crate filled with sand and 300 sun flower seeds with no flavoring, salt or shell in both a rural and urban setting. Then we watched the area for 3 hours making sure that the seeds were only taken by squirrels. After we counted up the amount of seeds left by pouring the sand through filter to draw out the remaining seeds from the sand. Then, we counted the remaining seeds and compared that number with original. We repeated this procedure three times for each setting. With the end results we found a mean of taken seeds for each setting and plotted on a bar graph.
Allelopathy is referred to as a form of chemical competition. One species releases an inhibitory chemical into the environment and it affects the development and growth of neighboring species. In an agricultural situation it is important to know whether crops grown next to each other will have a positive or negative biochemical affect on one another’s growth. This experimental design was used to investigate whether sunflowers (have an allelopathic effect on peas Sunflowers and peas were planted having in control groups, in addition a Our hypothesis is that sunflowers will have an allelopathic effect and reduce the growth of pea plants. We ran an ANOVA test and resulted in a p-value of .0217, therefore we fail to reject our null hypothesis and there is no significant difference in plant height or the number of peas grown.

The vernal pools at North Table Mountain Ecological Reserve in Oroville, California have many distinct features such as depth, surface area, shading, etc. The California newt (Taricha torosa) is a vernal pool resident that is reliant upon many different factors such as predation, the velocity of water, and the depth of the water among others. We predict that California newts in the Table Mountain area, which are subjected to seasonal pressures of stream flow, choose breeding areas in streams that will retain water flow the longest. Our study can further lead ecologists to the dynamics of T. torosa and their behavior, which is relevant to their distribution in Butte County. Through this experiment, we have found that deeper vernal pools are the most likely place to find a great number of newt population (P-value: 2.146x10^-9), and that the reproduction of the newts are very likely reliant on how much sunlight exposure there is and the optimal depth of vernal pools for mating (P-value: 0.0387). Within this text there are graphs and multiple statistics, such as P-values and R^2 values that confirm our beliefs on the different needs of newt mating and newt density.

The increasing number of invasive exotic plant species in many regions and the continuing alteration of natural ecosystems by humans often promotes hybridization between previously allopatric species as well as between native and introduced species. The spread of aggressive hybrid taxa can reduce the growth of, or often even replace, native species. There are damaging and increasing fatal effects of hybridization due to genetic effects of the hybrid species. It has been found that the number of stomata on a given plant affects the water intake, and further, the growth of a given botanical organism. For this reason, we chose to compare the stomatal densities of both the native and hybrid...
populations in sets of ten in order to determine the effects of hybridization on each species ability to intake water. The study was conducted on the California State University, Chico campus by a strategic process in order to predict the mechanisms and consequences of invasions mediated by hybridization and extensive data on hybrid ecology and biology that are needed in order to maintain the natural habitat on campus. We found that there was no difference in stomatal density between hybrid and native Sycamores (p-value = 0.145). Furthermore, our results implied that there are in fact similarities between the stomatal densities between each of the parental and hybrid species.

LD -33
Soil Quality Affects Pre-Existing Pea Plant Rhizobia Nodule Growth.
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Rhizobia are soil bacteria that fix nitrogen (diazotrophs) after becoming established inside root nodules of legumes like pea plants. Rhizobia require a plant host and they cannot independently fix nitrogen. Legumes are hypothesized to facilitate maintenance of soil quality; therefore they are often purposefully planted in between agricultural crops in an effort to maintain the quality of the soil during agricultural seasons. Legume co-cropping is especially important when nitrogen fertilizer is not used, as in organic rotation schemes. As such we are going to test to see if soil quality has an effect on pre-existing Rhizobia nodules associated with pea plants. We hypotheses that there will not be a growth difference in Rhizobia bacterial nodules due to soil quality or the Rhizobia bacterial nodules growth will be affected either positively or negatively by the soil quality. Immature pea plants with pre-existing Rhizobia nodules planted into depleted, control and enriched soil treatments will regenerated or maintain the soil quality, but there was no difference in nodule growth between the nutrient depleted soil treatment (p-value= 0.734) verses the enriched soil treatment (p-value= 0.979).

LD -34
Protozoa Species Richness in Big Chico Creek
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It is well known that pollution has negative affects on both abiotic and biotic entities of ecosystems. We conducted this project because we wanted to find out if Chico Creek was polluted and if so, how it affected the species richness in the surrounding habitat. We measured pH, as a reflection of pollution level, and estimated protozoa richness to show how the species richness varied across four different areas of Chico creek (Honey Run, Lower Park, Upper Park and the Train Tracks). Through our results, we found that there is a direct correlation between pH and the species richness of protozoa in the creek (R² = 0.7733). Since the pH (pollution) affects the protozoa richness, we know that it could also affects other life and thus lead to the degradation of ecosystems.
Upper Division Class Projects

UD-1
Optimal Foraging of Seed Predators in Upper Bidwell Park
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Varying species of animals exhibit many different foraging techniques with the majority sharing a common goal in striving to optimally utilize time and energy budgets. This theory of optimal foraging was tested with seed predators in the Upper Bidwell Park area of Chico, CA. Sunflower seeds, with shell and without, were put into separate aluminum pans and covered with a layer of sand. The pans were set out at the base of trees in which varying birds and squirrels were observed to have inhabited. Seed counts were conducted at twelve-hour periods, at four separate sites, and on three different days. Predictions that the preferred seeds were the ones without shells were drawn upon the realization that, due to less handling time, these would provide the highest caloric intake at the lowest caloric expenditure. Statistical analysis of seed counts confirmed this, as there were substantially lower counts of seeds without shells than there were of its counterpart. Conclusions were then drawn, confirming that seed predators in the Upper Bidwell Park do indeed exhibit optimal foraging techniques, preferably consuming seeds without shells over intact seeds.

UD-2
Comparison of the Biodiversity of Abandoned and Active Orchards of the Common Walnut (Juglans regia)
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This study was comparing the active walnut orchard at the California State University, Chico farm and a walnut orchard in Lower Bidwell Park that had been abandoned for thirty-five years. The objective of this experiment was to determine whether diversity of trees and herbaceous plants would differ between the two samples. The Quadrat Method was used to calculate the average density/100 m² of the different species of trees in each orchard. The Ring Toss Method was utilized in determining the mass of specific classifications of herbaceous plant materials individually and as a whole. The differences between the species of trees observed at each orchard - Valley Oak, Quercus lobata, and Chandler Walnut, Juglans regia – were found to be statistically significant, with P-values below 0.02. However, with a P-value of 0.15, the variance of the small, herbaceous plants between the abandoned and active orchards were not significant.

UD-3
Characterization of E. coli and Pseudomonas Bacteriophages Isolated from Sewage
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Viruses are found everywhere from oceans and arctic lakes to hot springs and stool samples. Recent deep sequencing studies of nucleic acids from virion enriched raw sewage identified known viral sequences from 26 taxonomic families and novel viral sequences that could be placed in 51 different families (Cantalupo, 2011). We were able to successfully enrich and isolate bacteriophage that can
infect *Escherichia coli*, *E. coli* ML30, and *Pseudomonas aeruginosa* from a raw sewage sample taken from the Chico wastewater treatment plant. We observed that each phage was specific to a narrow host range, non-enveloped, followed single hit kinetics, and the *E. coli* phage was observed to have a 29.8% attachment to its natural host. It was also shown by a one-step growth curve that the *E. coli* ML30 phage has a burst size of 500 virions per cell. Protein analysis of this phage by SDS-PAGE suggests two of our isolates are identical. While we were able to enrich, isolate, and partially characterize these phages, more work needs to be done, particularly on phage protein analysis, host range, and identification of the phages through sequencing.

**UD-4**

**Identification of Actinobacterium (Streptomyces)?**

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Organisms from *Streptomyces* can be obligate aerobes or anaerobes. The culture we worked with is an obligate aerobe, and thus, not pathogenic. Cells are gram positive filamentous bacteria with aerial mycelia and form endospores. *Streptomyces* are common in most soils and are known for their distinctive geosmin scent and antibiotic producing properties. They are difficult to culture as they are slow growing and are not nutritionally unique. Our project focused on attempting to identify the specific species of *Streptomyces* obtained from a soil sample provided by Dr. Wolfe that had been collected during a hike. Originally, we enriched for *Actinomyces* by growing the sample on oatmeal agar. After realizing that *Actinomyces* and *Streptomyces* share many similarities, we used morphological observations and incubation temperature to help differentiate between *Actinobacteria* and *Streptomyces*. We performed sugar fermentation, carbon source usage, nutritional requirement, lysozyme sensitivity, nitrate reduction, oxygen usage, catalase, casein, pH and salt concentration tests. The lysozyme sensitivity test showed that our isolate is not sensitive to lysozyme. Our isolate can use sucrose as a carbon source. It is catalase positive, does not reduce nitrate, and is an obligate aerobe. The organism is also capable of hydrolyzing casein into amino acids. We are giving the sugar fermentations, pH and salt concentration tests more time for growth as *Streptomyces* is very slow growing. We are in the process of trying to narrow down what species of *Streptomyces* we have isolated and are waiting on genotype results of 16S ribosomal RNA.

**UD-5**

**Investigation of peroxidase proteins and their role in lignification**

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Peroxidases are a class of proteins that catalyze a reaction to form lignin which is the primary structural component of plant cell walls. Intracellular location of a protein indicates the protein's role. Peroxidases that form lignin will be located in the cell wall; other peroxidases will be located within the cell vacuole. From the 73 proteins in the peroxidase family, AT1G05260 was chosen, and its role in lignification in the organism *Arabidopsis thaliana* was investigated. AT1G05260 lacks the endoplasmic reticulum retention sequence KDEL and was hypothesized to be released from the ER. From the hydropathy character of the last amino acids in the protein, AT1G05260 was further hypothesized to be located in the cell membrane rather than the vacuole. Primers were designed for tri-template PCR (TT-PCR) assembly of AT1G05260 with yellow fluorescent protein (YFP). Agarose gel electrophoresis of the PCR product indicated successful assembly. The reporter construct was then isolated and cloned into the plasmid vector pDONR221. The vector was transformed into *Escherichia*
coli. Colony PCR indicated a successful transformation with the plasmid and the presence of the YFP gene in the transformed E. coli. The plasmid was isolated from transformed E. coli and subcloned into plant transformation vector pMN20GW. The resulting binary vector was then transformed into Agrobacterium tumefaciens for use in transformation of A. thaliana. Colony PCR of transformed A. tumefaciens indicates a successful transformation with the plasmid and the presence of the YFP gene in the transformed bacteria.

UD-6
Enrichment of Purple Non-Sulfur Bacteria
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Purple non-sulfur bacteria undergo anoxygenic photosynthesis. They use organic compounds as the electron donor to complete this process. Bacteriochlorophyll a or b are produced giving the bacteria the purple/red to brown pigmentation. Rhodopseudomonas, Rhodospirillum, and Rhodomicrobium are classified as purple non-sulfur bacteria and are part of Proteobacteria family. These bacteria are all are gram-negative. Purple non-sulfur bacteria can be found in mud in ponds or lakes. The purpose of this project was focusing on the enrichment and isolation of specific species of purple non-sulfur bacteria. We obtained our inoculum from Dr. Wolfe’s growth of purple non-sulfur bacteria. We originally made media specific for purple non-sulfur bacteria and placed them in test tubes covered with paraffin to obtain an anoxygenic environment for optimal growth. Two days later we made Petri plates containing the same media and used the same sample for inoculation. We placed these plates in anaerobic and aerobic environments and let them grow for five days. We found colonies that appeared to have red pigments using the dissecting microscope. We streaked these plates, performed a gram stain, and used one of these colonies to perform a PCR reaction. The bacteria stained as gram-negative, rod shaped and the PCR reaction will give us a genotypic classification based upon the 16S rRNA gene of the organism. We plan to also perform more phenotypic tests.

UD-7
Designing Primers for use in Tri-Template PCR to Quantify Peroxidase Gene at1g05260 of Arabidopsis Thaliana
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The class III secretory peroxidase genes in Arabidopsis thaliana are important for study as a result of their early expression in plant development. The early expression of peroxidase genes makes them an ideal candidate when designing a reporter construct so that one could potentially determine where in the plant cell the functional protein is targeted. Bioinformatics tools, such as Genevestigator, TAIR, and PSORT were utilized to assist us in our investigation of the class III secretory peroxidase genes. Genevestigator provided us with a “Heat Map” and was used to select an appropriate peroxidase gene (at1g05260) for study based on its expression potential in root tips. TAIR allowed us to visualize the DNA sequence of the gene so that gene-specific primers could be constructed, while PSORT provided the information needed to determine that the synthesized polypeptide would enter and remain in the secretory pathway via an N-terminal signal sequence and
the absence of the C-terminus amino acids, KDEL. Total genomic DNA was isolated from *A. thaliana* leaf tissue using a genomic DNA isolation protocol. Tri-template PCR was performed to amplify reporter construct components required for the assembly of the YFP reporter. Agarose gel electrophoresis confirmed the proper assembly of our reporter gene based on the expected size of the resultant, fluorescently tagged product. The successful assembly of this construct suggests that it could be used in further research to study the expression and the target of the class III secretory peroxidase gene in *A. thaliana*.

**UD-8**

The H-Philes: Investigation of the Strange and Unexplained of Bacterial Halophiles.

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Halophiles are salt loving organisms that can grow in various concentrations of salt ranging from 3% to 30%. Common environments in which halophiles can be located are salt lakes, saline soils, and salted food products (Ventosa, 1998). Halophiles are also typically located in aerobic environments (Oren, 1988). For our project, we attempted to isolate Halophiles and identify the optimum growth concentrations of salt. We isolated a halobacterium from the salterns in Baja, California. The sample was first streaked on media at a concentration of 10% salt, and was then re-streaked on plates with concentrations of 5%, 15%, and 20% salt. We then inoculated liquid media with inoculums grown at 3.5%, 10%, and 17.5% and measured it’s growth over 20 hours in various salt concentrations using a turbidimetric assay (abs 540). We found our halophile to most successfully grow at 5% and 15% salt concentrations. We performed PCR of our isolate and it revealed we do not have a pure culture at 5%, which explains the difference in optimum growth concentrations of salt. The PCR results also indicated that our isolate in bacterial and not Achaea. We are currently waiting on results from sequencing to get a more definite answer as to the identity of the isolate. The TRUTH is out there.

**UD-9**

Impact of Seed Predation on Redbud

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Plants and insects have a large range of interactions that can be both advantageous and detrimental to either party. Understanding these interactions gives insight concerning the factors that control the distribution and abundance of a species. The specific interaction encompassed in our study is seed predation. Seed predation can have a large negative impact on plant fecundity; the potential reproductive capacity of a species. The particular plant species involved in this study is the *Cercis occidentalis*, commonly known as redbud. The Redbud is sometimes a victim of seed predation. They are most likely preyed upon by moths or beetles that lay their eggs on developing redbud fruits; resulting in larvae that attack the seeds inside. Our working hypothesis is that seed predation will result in the destruction of at least thirty percent of each redbud’s total seeds. Our study involved randomly selecting five individual redbud trees and then randomly collecting thirty pods from each tree. The seeds for each individual redbud were counted and identified as damaged or undamaged. On average each redbud lost twenty-three percent of its total seeds with a standard deviation of ten. With such a large standard deviation it is evident that a larger sample size is needed to measure the impact of seed predation on redbuds; therefore we can neither accept nor reject our hypothesis. It is clear however that seed predation has an impact on redbud fecundity.
The California Acorn Weevil, *Curculio uniformis*, bores holes in the acorns of many native oak tree species to incubate its larva. Our experiment should have shown a direct correlation between increased acorn size and an increase in weevil bore hole frequency. We collected acorn samples from two distinct biomes, the California blue oak savannah and chaparral. We used a point-quadrat system, a method of randomizing our acorn selection. Acorns from the blue oak savannah were smaller than the acorns found in the chaparral. We found a greater likelihood of bore hole presence within the larger sized acorns. (Swiecki, 2006). The number of bore holes found in each acorn rarely exceeded one. Our experiment found that female weevils showed a preference for larger acorns but that the preferred number of bore holes was one. Further research is needed to determine why acorns tend to only have one bore hole.

Allelopathy is a type of interference competition during which, one species of plant inhibits seedling growth through the secretion of noxious chemicals. We predicted that some of the species will have a greater effect of germination of other species; which would be seen in the effects on the control group (cucumber). For testing, we looked at five different plant species. The five species are: California Bay Laurel (*Umbellularia californica*), white Clover (*Trifolium repens*), Eucalyptus (*Eucalyptus cineria*), Manzanita (*Arctostaphylos manzanita*), and Sage. We collected samples of each from either the Upper Bidwell Park in Chico, CA or at a local gardening store. During testing, we took the leaves from each of the samples and crushed them to make water extracts. The extracts were then put on filter papers and combined with cucumber (*Cucumis sativus*) seeds and covered with top soil to let grow. After letting the seedlings grow, we came to the conclusion that different plants may allelopathic effects on the seedlings of the cucumber which are stunting the growth or germination inhibition.

The focus of this research project was to evaluate the relative diversity of Oak gall insects in Upper Bidwell Park along a river versus a stream. Our question was whether water contributes to more diversity being present within the gall itself. Our alternate hypothesis was that there is a difference in the diversity of species along a river versus a stream due to water availability and our null hypothesis was that there is not a difference in diversity due to water availability. One-hundred and twenty-five galls were collected from both a river and a stream location and then placed into zip-lock bags. These bags were monitored every two weeks and the insects that emerged were collected and
classified to order. The data was then compiled and a t-test along with a Shannon Diversity Index was used to analyze it. The t-test result was a p-value of 0.8262 and the Shannon Diversity Index along the river was 1.189 and the stream was 1.193. These results support our null hypothesis in that there appears to no correlation with water proximity and the diversity of species within an Oak gall. This could be due to the scale of our sampling area or the fact that we were only able to classify our species to order.

UD-13
Effect of Foliage Height Diversity in Restored Riparian Habitat on Bird Species Diversity
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We conducted a survey of the Pine Creek Unit of Sacramento River National Wildlife Refuge avian community within a restored riparian forest habitat near Hamilton City, Butte County, California. Surveys were conducted during April 2012. Our 1 ha study area was divided into transects designed for surveying both the plant and bird communities. We determined the species composition of both the bird and plant communities within our study area and calculated foliage height and plant species profiles for our study area. We generated Shannon diversity (H') values for plant species, foliage heights, and bird species. Our H’ values were used to determine whether birds are using the various plant species and foliage heights randomly or selectively. Our hypothesis is the greater diversity of both plant species and foliage height, and the greater use of these habitat components by birds; therefore greater bird diversity. The most common avian species at our site include tree sparrows, yellow-rumped warbler, and Bullock’s orioles. Our results will be presented on our poster.

UD-14
Leaf Decomposition Rates in Woody Trees
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The purpose of our study was to examine the nutrient cycling of plants in our local ecosystem. We investigated whether there is a correlation between leaf type and rates of decomposition in freshwater, aquatic environments. The rate at which nutrients are released from dead leaves is a critical aspect of nutrient cycling in aquatic communities. To better understand the cycling, we collected leaves from three different trees on the Chico State campus: Valley Oak, Manzanita, and Redwood. To measure decomposition rates we used a freshwater source, over a four week period. The deciduous Valley Oak decomposed the quickest with a 81.4% mass loss over the course of the experiment. Manzanita decomposed the least with a 49.8% mass loss. Statistical results regarding final rates are pending, but preliminary data suggests that deciduous species cycle nutrients more efficiently through their release of leaf litter while evergreen species produce more resistant leaf litter. The study provides insight into the relative contributions of nutrients to the nutrient cycles of the freshwater aquatic ecosystems from trees.
A study was conducted to observe the response stimuli of *Armadillidium vulgare* (common pillbug) to varying soil moisture. The pleopodal pseudolungs of the pillbug make them particularly sensitive to changes in soil moisture levels. Conglobation, the act of rolling up in a ball, reduces the amount of water lost to the environment by decreasing the surface area of the pleopodal pseudolungs (Warburg, 1968). We hypothesized that conglobation is an adaptive response which reduces the risk of desiccation. Thirty pillbugs were collected from the CSU Chico campus. An analog soil moisture sensor was utilized to record data. A soil moisture (SM) level of 4 was measured at the collection site and used as the control. The pillbugs were divided into three plastic bins: the control, treatment 1 (dry, SM=1), and treatment 2 (wet, SM=7) each containing four centimeters of soil from the collection site. The behavior of the pillbugs was observed over a two week period and the number of individuals conglobating was measured twice daily, in the morning and at night. Analysis of our data showed statistically significant variances in the rates of conglobation between treatment groups as well as between observation times. The highest rates of conglobation were observed in the dry treatment, while the lowest rates were observed in the wet treatment. Higher rates of conglobation in all treatments were recorded during the morning observation time. These results allow us to conclude that conglobation is an adaptive response which reduces the risk of desiccation.

When characterizing and classifying Butte County crayfish to the taxonomic level of species, it is essential to have an appreciation and an understanding of the habitats that crayfish occupy. The experimental hypothesis that we investigated was that the exotic / invasive freshwater crayfish species (*Procambarus clarkii*), will be most prominent out of the total crayfish sample collected. The methods employed throughout the course of our study were to construct and bait crayfish traps and to disperse them to various locations alongside Big Chico Creek, and Pine Creek. Habitats were characterized by the presence of the aquatic plant, *Elodea*, and by testing pH, temperature, and solute concentration of the associated waters. The collected crayfish were then characterized based upon their physical attributes which therefore provided us with the information needed to classify the crayfish to species. As a result of our freshwater crayfish study in Butte County, we were able to further verify that in fact the exotic species, *Procambarus clarkii*, is more pronounced in the waters that we sampled.

California has its own subspecies of Pipevine Swallowtail, *Battus philenor hirsuta*. They are a familiar sight in Chico, often seen flying from early spring towards fall. Aside from the annual butterfly survey...
done at Big Chico Creek Ecological Reserve, there has not been a system of consistently surveying the population enough to know about significant changes in population composition (including sex ratios), their phenology, as well as their local range in Chico.

This study focuses on developing a method of conducting long-terms surveys for California Pipevine Swallowtails that are repeatable in biology classes, have the ability to benefit from community input/citizen science, and can add to the permanent collection. To develop capture and release methods, I collected butterflies in One Mile and Five Mile of Bidwell Park over a period of two months, starting early March. The capture date, gender, presence of pollen, wingspan, as well as types of damage inflicted on the body/wings were recorded. In order to account for their range, I kept a record of Pipevine Swallowtail sightings on googlemaps. Starting in early March, a total of 18 butterflies were caught, of which 13 were male and 5 were female, resulting in a sex ratio of 2.6. Long-term surveying Pipevine Swallowtail will allow us to identify locations to conduct Pipevine Swallowtail projects as well as provide preliminary data for projects related to population dynamics and interpreting the effects of climate change on butterfly behavior.

**UD-18**

**Creating Gene Reporter Constructs of *Arabidopsis Thaliana* Class III Peroxidase Genes**

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In order to investigate the function of genes in living organisms it is necessary to be able to monitor the expression of genes. In our experiment, the class III peroxidase gene at2g38380 of *Arabidopsis thaliana* was selected for the creation of a reporter gene construct. This reporter construct, if successful, would contain the full, operational sequence of the original class III peroxidase gene, as well as a detectable genetic tag. Additionally, the gene reporter construct would need to be able to be successfully cloned into a plasmid vector and then transformed into *Escherichia coli* for eventual sub-cloning into other bacterial or plasmid vectors.

The at2g38380 gene was sequenced and primers were designed to amplify certain fragments of this gene through PCR. Then a yellow fluorescent protein reporter gene (yfp) was inserted into the peroxidase gene through a tri-template PCR reaction involving both the yfp reporter gene and the designed fragments of the peroxidase gene. This yfp tagged gene construct was cloned into plasmid pDONR221, which was then transformed into *E. coli*. Every step of this process was shown to be successful by gel electrophoresis of PCR products, and finally by selective media culling of the transformed *E. coli* colonies to insure the presence of the pDONR221 plasmid.

By the end of this process we were successfully able to create transformed *E. coli* colonies containing the plasmid, which in turn contained our reporter gene construct. These constructs could be further used for experimentation on *A. thaliana*.

**UD-19**

**Isolation of Myxobacteria from Rabbit Dung**

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Myxobacteria are proteobacteria in the delta group. The bacteria are predominantly found in the soil. They are gram negative rods that glide and travel in swarms and are known to be predatory
bacteria. Our group’s project focused on the enrichment and isolation of myxobacteria from rabbit dung provided by Dr. Wolfe. Initially we inoculated water agar with prey bacteria *E. coli* and placed a rabbit dung pellet dipped in cycloheximide in the middle of the agar to enrich myxobacteria. That plate was incubated at 27 °C for 4 days. After incubation we observed that fruiting bodies may be starting to form. The plate was allowed to incubate for 2 more days in which we saw a fruiting body formation, which we plated on TSA to enrich the growth of myxobacteria. The plate was incubated at 27 °C for 2 days. A gram stain was taken of one of the colonies on the plate and showed that the sample was contaminated. There were 3 different cells seen, gram negative and positive rods as well as some rods sporulating. Another TSA plate was inoculated to isolate a colony as well as 3 agar plates with 3 different prey bacteria with suspected fruiting bodies. The goal of this project is to isolate myxobacteria from rabbit dung and characterize the species genetically and phenotypically. We are in the process of receiving and evaluating our PCR data and the 3 agar plate with different prey bacteria.

**UD-20**

**Isolation of the Deinococcus radiodurans extremophile**

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Exposure to ionizing UV and gamma radiation is lethal to the majority of microbes prevalent in our environment. However, some extremophilic microbes such as *Deinococcus radiodurans* are highly radiation resistant due to advantaged DNA repair enzymes as well as other adaptations. This gram negative, obligate aerobic chemoorganoheterotroph is known as the most radiation resistant organism. *D. radiodurans* was isolated and characterized both phenotypically and genotypically. An initial mixed culture was inoculated from an obtained soil extract and then enriched for using a *The Corynebacterium* plates were prepared using the Handbook for Microbiological Media. In order to isolate the *D. radiodurans* extremophile, the initial mixed culture sample was exposed to UV radiation for 20 minutes. Once isolated its radiation resistance was compared to *Serratia marcescens* via an ionizing UV light source. The growth of both the *S. marcescens* and *D. radiodurans* cultures was compared by colony count after exposure to UV radiation through several trials at a variety of exposure times. Further assays such as a Gram-Stain analysis, oxygen utility, motility, desiccation, and salt tolerance were performed in order to phenotypically confirm the isolation of *D. radiodurans*.

**UD-21**

**CSU Chico Nestbox Monitoring Protocol**

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Many bird species require tree cavities to perform their nesting behavior each year. When such habitat is not available, man-made nestboxes can be placed on trees to provide the birds with useful habitat. It can also be a way for adults and children to observe firsthand the nesting behavior that would otherwise be hidden inside of a tree. The purpose of our Field Ecology project was to construct nestboxes as well as use a few that had already been built and place them along the creek running through the CSU Chico campus. It was our goal that these boxes will attract Western Screech Owls (*Megascops kennicottii*) as the prime species of interest. Our plan was to create protocols for monitoring of the boxes, regular cleaning, and pest management in order to keep the boxes in top shape for years to come. We would hope these nestboxes could serve as a learning tool not only for
future Field Ecology classes, but also for future Ornithology, Ecology and other biology classes to share a role in recording data and observations. With many classes participating, monitoring could become a regular part of the curriculum taught on campus and a long term data set could be attained.

UD-22
Habitat Utilization and Selection by Birds of the Chaparral, with Notes on Avian and Plant Diversity
Lindsay McDonnell, Jessica Simons, and Emily Thompson
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We conducted a survey on the bird community and their habitat utilization within the Chaparral habitat of Butte County in Northern California. Our site is located within the Tuscan Loop of the Big Chico Creek Ecological Reserve off Highway 32. Birds were observed and recorded during six separate field outings at a one-hectare transect right after sunrise during the month of April 2012. The objectives of our study were (1) to determine avian and vegetation species composition within our study area, (2) to create a foliage height profile for our site, (3) to calculate and then analyze the relationship between Shannon Diversity values (H’) for avian species, foliage height, and plant species within our habitat type, and (4) to determine whether birds are randomly or selectively using those plant species and vegetation foliage height intervals present within our study area. Our null hypothesis states that there will be no differences in habitat utilization by birds in regards to plants species diversity and foliage height diversity. The results and data analyses will be presented in our poster.

UD-23
Gene Expression of AT1G05260 in Arabidopsis thaliana
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Arabidopsis thaliana is a model organism, containing 73 class III secretory peroxidases genes. Class III secretory peroxidases function in cell wall lignification of A. thaliana. The purpose of this experiment was to design a genetic construct to amplify fragments of a Class III secretory peroxidase protein that when fused with with yellow fluorescent protein which would allow for visualization of gene expressed in plant tissue. Based on the heat map of peroxidase family genes produced by Genevestigator, it was hypothesized that gene at1g05260 would be expressed in high abundance in the root tips, due to its role in cell wall lignification. The TAIR database was used to determine that the gene of interest had signal peptides that could transport the protein outside of the endoplasmic reticulum. Gel electrophoresis of fused TT-PCR products were obtained and cloned into the plasmid of competent Escherichia coli cells. These cells were cultured and the plasmid was isolated. The plasmid was subcloned into a second plasmid and used to transform E. coli cells. The binary vector subclones were isolated and used to transform of Agrobacterium tumefaciens cells. A. thaliana was transformed by floral inoculation using A. tumefaciens, to target developing eggs. To ensure that only transgenic seeds germinated, the seeds were extracted from the siliques and plated on selective media which was treated with kanamycin. The resulting seedlings were analyzed using a fluorescent microscope to test for the presence of a fused AT1G05260::YFP peroxidase protein.
UD-24
The effects of human disturbance on behaviors of Acorn Woodpecker, Melanerpes formicivorus, at Lower Bidwell Park granaries
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The objective of this experiment was to study Acorn Woodpecker activity in two granaries of varying levels of human disturbance at the One Mile recreation area of Bidwell Park in Chico, CA. Our hypothesis was that there would be a significant difference in activity levels between habitats with relatively high disturbance and relatively low disturbance. We observed individual birds in each granary in one minute increments, recording whether or not each bird did any of the following activities: preening, talking, moving, flying, pecking, or socializing. We found that there was a significant difference between the two locations in flying (p=0.02) and socializing (p=0.01), but not among any of the other activities (p>.05). This suggests that human disturbance may impact Acorn Woodpecker behavioral habits and interactions.

UD-25
Habitat Utilization and Selection by Birds in a Blue Oak Woodland Habitat, with Notes on Avian and Plant Diversity
Nikki Ramey, Noah Strong, Mike Castillio
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We evaluated the avian community within a blue oak woodland habitat located at the Wurlitzer Ranch 25 km north of Chico, Butte County, California. Our study examined hypotheses set forth by MacArther and MacArther (1961) which suggest that a selective relationship exists between birds and both plant species and foliage height interval within a particular habitat. We set up transects on our study site, which covered a 1 ha area. Transects contained 100 vegetation measurement points which were spaced at 10 m intervals. This study took place during the months of April and May 2012, between the hours of sunrise and 9:30 a.m. Our goals were: (1) to assess the species composition of the avian and plant communities within our habitat, (2) to generate foliage height and plant species profiles for the vegetation present, (3) to calculate Shannon diversity (H') values for plant species, foliage heights and bird species, and (4) to determine, through a series of avian surveys, whether birds are randomly or selectively using plant species and foliage height intervals within their environment. Our null hypothesis states that there are no differences between the availability of the various plant species and foliage height intervals on our study area and the utilization of these vegetation components by birds. The most commonly observed bird species within our oak woodland study area include the Yellow-rumped Warbler, Acorn Woodpecker, Oak Titmouse and European Starling. Our results and findings will be presented on our poster.

UD-26
Population Distribution of Night Flying moths as an Indicator of Habitat Quality and Climatic Change in the BCCER
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Moth distribution surveys can serve as environmental health and quality indicators. Their distributions can also document first flight appearance that can be correlated to climatic changes. Moth distribution particularly within Butte County is lacking. A moth survey in Big Chico Creek
Ecological Reserve (BCCER) was conducted in April and May using black light pit fall traps. Nighttime flying moths were selected to collect because a regular collection scheme could be adopted and implemented on an annual or semi annual basis by the Field Biology 484 class. Our survey revealed over 30 specimens with >10 different specie identifications. All specimens have been pinned and placed in a museum insect box and will be donated to the Gateway Science Museum.

UD-27
Enriching for Cyanobacteria
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Cyanobacteria are oxygenic bacteria that use two different photosystems to split water and use it as an electron donor to produce oxygen. They are extremely diverse and can be found in various forms such as small single cells to large filamentous colonies. Regardless of their different shapes, they all contain chlorophyll a and two proteins that give them their blue-green pigments. They grow optimally in aerobic environments where sufficient light and nutrients are present. For our enrichment we isolated our culture from the pond water provided by Dr. Gordon Wolfe. Cyanobacteria require a carbon source along with sodium, sulfur, phosphorous, magnesium, calcium, and some trace metal in order to photosynthesize and grow. The enrichment media that we used included 0.05 g NaHCO3, 0.01 g NaCl, 0.05 g (NH4)2SO4, 0.05 g K2HPO4, 0.01 g MgSO4, 0.005 g CaCl2, 1% addition of trace metals solution, and cycloheximide. Cycloheximide was added to inhibit protein synthesis of eukaryotic organisms that compete with cyanobacteria. After two weeks of inoculation blue green growth was observed and transferred to media plates. A pure culture was isolated from the media plates. Gram stain, wet mount and florescence microscopy confirmed the isolated culture was cyanobacteria. A PCR test is currently being conducted to further identify the isolate.

UD-28
Habitat Utilization and Selection by Birds of the Sacramento River Old Growth Riparian Forest Habitat with Notes on Avian and Plant Diversity
Melissa Sutton, Carolyn Miller, Branden Hendrix, and Jordan Stambaugh
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We conducted a survey of the Sacramento River avian community within an old-growth riparian forest habitat in Glenn County, California. This site is located at River Mile 193.5-R, approximately 5 miles south of Hamilton City. Surveys were conducted during April, 2012. Our study area was divided into transects designed for surveying both the plant and bird communities. Our goals were (1) to determine the species composition of both the bird and plant communities within our study area, (2) to calculate foliage height and plant species profiles for our study area, (3) to generate Shannon diversity (H') values for plant species, foliage heights, and bird species, and (4) to determine whether birds are using the various plant species and foliage heights randomly or selectively; our null hypotheses being that there are no differences in the availability of both plant species and foliage height intervals, and the utilization of these habitat components by birds. Our results will be presented on our poster.
We developed a standardized protocol for camera-trapping Cougars in the BCCER, which is located approximately seven miles northwest of Chico, California. We tested the effectiveness of our protocol during Spring, 2012. Within the BCCER, three sites were chosen and two motion activated cameras were deployed facing each other with a scent lure placed midway between them. The site was visited periodically to collect data cards and refresh the scent lures. All data and photographs were entered into standardized logs.

This project was undertaken for several important reasons. There appears to be no recent studies recording the status of cougar populations within Butte County. As top-level predators with large ranges, cougars have a tremendous impact on ecosystems of which they are a part. Previous studies have shown that habitat fragmentation and the impacts of the urban interface can have deleterious consequences for adjacent wildlife populations. In order to assess the effects of urbanization and habitat fragmentation on cougars, a reliable method for assessing their current status must be established. It is our hope to establish a protocol that can be implemented for long-term cougar monitoring. Our results will be presented on our poster.

Non-native species have the potential to disrupt natural ecosystem processes in environments that they establish. Invasive species establishment is often contingent upon the activities of humans in the area. Wild turkeys (*Meleagris gallopavo*) are an introduced species that is popular with game hunters. Their impact on the flora and fauna of our area is largely unknown due to a lack of data acquisition. The goal of our study is to set up a monitoring protocol and infrastructure in which the diet of these animals is assessed. By determining what these animals are eating in specific regions, we can potentially discover their impact on certain organisms.

The Big Chico Creek Ecological Reserve is an important piece of land for CSU Chico student research. Every year a lottery for turkey hunts is held, allowing select individuals to get an opportunity to hunt turkeys. Our goal was to utilize the hunt program already in place to coordinate with successful hunters to be able to obtain as many turkey crops as possible to assess their diet in the Big Chico Creek Ecological Reserve.
The Western Pond turtle, *Emys marmorata*, is a small to medium sized turtle and the only native turtle found on the CSU Chico reserves. Its coloration is typically a nondescript mix of brown, amber, and black and they can usually be seen basking on exposed logs and boulders. Currently, the Western Pond turtle is not federally listed however, their numbers are in decline throughout most of their range and in California they’re listed as a species of special concern. Data has been gathered on the populations inhabiting the reserves since September of 2000; however there is no standardized protocol in place for data collection methods. This protocol will standardize future data collection with current research efforts, making the dataset more useful and comparable across time, and will provide future students, staff, interns and other interested parties with current data collection methods for this sensitive species. Long-term data collection and monitoring are essential to conservations effort because they help detect small changes in populations, help discern long-term trends, monitor a long-lived species on a time scale more relevant to their life history, and detect changes in sensitive species populations.
Undergraduate Research

UR-1
Investigation of Ion Channel Gene Involvement in Wound Healing
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Summer Internship at the Center of Regenerative and Developmental Biology: The Forsyth Institute and Harvard Medical School: BIOL 489 (Patricia Edelmann pedelmann@csuchico.edu)

Ion channels play an important role in wound healing including regeneration and scar formation. The goal for this project is to determine which ion channel genes are involved in regeneration, the localization of these genes and the change of their expression level during the wound healing process. Hypothesis for the change of gene expression: if gene expression is increasing during the wound healing, then we consider it enhances the process; if gene expression is decreasing during the wound healing, then we consider it rejects the process; if a gene has no change during the wound healing, then we consider it is not involved in the process. Mouse embryos were wounded and tissue samples were taken over time to determine gene expression via RT Profiler PCR Array, Real time PCR, Western Blot and RNA Wholemount in Situ Hybridization techniques. Data interpretation and conclusions are yet to be published by the Forsyth Institute.

UR-2
Investigation of the Antimicrobial Activity of Metallated Thiosalens
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The amount of antibiotic-resistant pathogens is increasing at an alarming rate, and the need for newer, more effective antibiotics is now at its greatest. This project has been dedicated to synthesizing novel compounds and determining their antimicrobial effects in the hopes of finding new potential antibiotics. We have been investigating the mechanism of action for a particular metallated thiosalen complex that has shown promising antimicrobial effects against several species of gram-positive bacteria. We thus determined the MIC to be approximately 100 uM, comparable to antibiotics such as penicillin. Once determined, we set out to examine the effects of this salen on the growth kinetics of our test organisms; Staphylococcus epidermidis and Escherichia coli. We found that the salen is extremely bactericidal against S. epi and is effective in as little as 2 hours. Against E. coli however, it became much less effective and was only bacteriostatic. Given the rate of effectiveness, it led us to believe that it could be acting upon the membrane of the organism. Thusly we have begun devising an experimental assay to determine the membrane permeability by tracking the release of alkaline phosphatase over time using PNPP measured by a spectrophotometer at 405 nm. The results of this assay are inconclusive and the procedure is still under development.

UR-3
Management Practices for the Removal of Invasive Red-eared Sliders (Trachemys scripta elegans) from an Aquatic Ecosystem
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Native Red-eared Slider (Trachemys scripta elegans) populations exist in the Midwestern United States but due to their popularity as pets and their hardy biological characteristics they can now be found on almost every continent in the world (Semenov, 2009). These turtles have the potential to
damage the ecosystems they now invade and because of this, efforts were made to remove them from an aquatic ecosystem in Chico, CA. The primary goals of this removal effort were to establish the average Catch per Unit Effort (CPUE), gain knowledge on the most efficient use of traps, establish how many turtles could be caught in a 6 month period (May-October), and discover what could be done with these turtles once they were removed. An adoption program was established to find homes for the removed Red Eared Sliders (*T. scripta elegans*). The goal of this program was to educate the public about invasive turtles in California and teach responsible pet ownership. It was found that there was some evidence that Catch per Unit effort decreased over time ($R^2 = 0.25$) with an average of 2.4 turtles caught every 100 trap-hours. 66 Red-eared Sliders were removed in a 6 month period and 43 were given to suitable homes. The optimal length of time to leave a trap out was between 20 and 40 hours. There was strong evidence that on average, individuals who adopted a turtle knew more about invasive species after adopting a turtle when compared to before adopting a turtle ($p= 0.0005$).

**UR-4**

**Analysis of factors influencing germination of an acidophilic, thermostolerant ascomycete fungus**

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Biol 499H - Independent Honors Research

*Ochroconis* sp. is a dematiaceous ascomycete found in low pH, high temperature environments such as thermal soils and hot springs, and our lab has isolated an *Ochroconis* strain from Boiling Springs Lake, Lassen Volcanic Park, a pH 2.2, 52 °C geothermal feature. Little is known about the factors affecting the germination of thermophilic fungi. I am conducting germination experiments to determine the effects of temperature, pH, and nutrients on the germination, by measuring the percent of spores that produce germ tubes. Using direct microscopic observations, I found that *Ochroconis* sp. spores contain all the essential nutrients for germination, and that temperature is a critical factor in initiating germination. The spores are highly acid tolerant, capable of germination even at much higher than optimal temperatures and that at these extremes excess nutrients are able to overcome these stressors, allowing for maximal germination.

**UR-5**

**Phenotypic relationships of residual feed intake with growth and measures of efficiency in Angus growing bulls**

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ANSC 499

The objective of this study was to determine the phenotypic relationship of RFI with growth and efficiency measures in Angus growing bulls. Individual feed intake data were collected for bulls fed in 2007 (n=91, d=62), 2008 (n=60, d=72), 2009 (n=32, d=73) and 2010 (n=50, d=78) using the GrowSafe automated feeding system. Efficiency measures determined were partial efficiency of growth (ADG/DMI for growth; PEG), feed conversion ratio (DMI/ADG; FCR), Kleiber Ratio (ADG/mid-test metabolic body weight), and residual feed intake (RFI) computed as the difference between the actual DMI and predicted DMI from the regression of DMI on ADG and mid-test metabolic body weight (MMWT). Animals were divided into low (<-0.5 SD; RFI= -0.741 kg/d), marginal (±0.5 SD; RFI=0.004 kg/d), and high (>0.5 SD; RFI=0.735 kg/d) RFI groups. RFI group means were analyzed using ANOVA, including the fixed effects of RFI group, year, and interaction term when significant ($P<0.05$). No significant differences existed among RFI groups ($P>0.05$) for test start weight, test end weight, ADG, MMWT and Kleiber Ratio. Significant RFI group differences were detected for FCR and
DMI (P<0.01). Low RFI grouped bulls appeared to have a more favorable FCR (5.58 kg) with reduced DMI (10.01 kg/d). Correlations of RFI with growth measures were not significant (P>0.05); the correlation of RFI with FCR was significant (r = 0.42; P<0.05), supporting results of the RFI groups analysis. Results suggest that phenotypic selection of bulls with low RFI can be used to improve efficiency of growth without adversely impacting test performance.

**UR-6**

The biogenesis of microRNA-375 in pancreatic beta cells
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BIOL 399

MicroRNAs (miRNAs) are short, non-coding RNA molecules that regulate gene expression in nearly all eukaryotes. Studies have shown that the presence of microRNA-375 (miR-375) is necessary to maintain pancreatic beta cell mass; the absence of miR-375 in these cells leads to decreased beta cell mass and misregulation of blood glucose levels in a rodent knockout model. The gene structure of miR-375’s unprocessed primary transcript (pri-miRNA) is not completely understood; the structure of a pri-miRNA is significant because it may contain regulatory sequences that affect the expression of the microRNA. A technique known as rapid amplification of cDNA ends (RACE) analysis was shown to be viable for end-analysis of a low-abundance mRNA (encoding Pcsk1). 3’ RACE was performed on miR-375, and a 3’ end has been identified. Additionally, evidence suggests the existence of different isoforms of pri-miR-375 – miR-375 may have multiple 3’ ends. These results may have important implications for better understanding the regulation of miR-375.
Graduate Class Projects

**GC-1**  
**Using bioinformatics to predict the function of a hypothetical protein**  
Areeje Almasary pyt@maktoob.com  
BIOL 612: Dr. David Keller (dmkeller@csuchico.edu)

Genome research produces many hypothetical proteins that have no assigned functions. In this project, I am using bioinformatics tools to predict the function of a hypothetical protein (YBL113C) from Saccharomycetales. Biochemical/molecular techniques are costly, so bioinformatics tools can be used to find interesting proteins which can be followed up by experimentation to characterize these proteins.

**GC-2**  
**SNPs, Drugs and Pharmacogenomics**  
Bryan Ervin bervin@mail.csuchico.edu  
BIOL 612: Dr. David Keller (dmkeller@csuchico.edu)

Single nucleotide polymorphisms (SNPs) are point mutation within long stretches of identical regions of the genome that accounts for variability among humans. Utilizing SNPs, we can cluster together human populations (haplogroups) and look for correlations between observable traits (phenotypes) and genetic code (genotypes). These correlative studies have been used to help understand heredity and appearance but more importantly we are can study the efficacy and reactions to pharmaceuticals drugs. By combining genome-wide association studies, SNP data from direct to consumer tests and drug side effect/efficacy reporting databases; we should be able to reasonably predict an individual’s reaction to a drug they have yet to encounter: a process termed pharmacogenomics. To test this, I compared the genotypes of two known and eight random individuals from the openSNP.org database against genetic markers of eleven drugs (e.g. Aspirin, Warfarin, etc.) via DurgBank.ca database to correlate clinical outcomes at an individual level. Results show unique patterns of drug outcomes for each individual even among drugs that interact with the same enzyme (Cytochrome P450). Although this experiment represents a small sample size, the correlation-causation abilities show promise. As more and more people discover their genotypes (or full genetic sequences), we can tailor specific treatments and avoid side effects.

**GC-3**  
**Effects of constant and alternating wind on plant growth**  
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One of the abiotic factors affecting plant growth is mechanical stimulation of wind. Wind can reduce biomass, but plants can compensate when released from wind exposure by growing quickly to match control plants that were never exposed to wind. However, previous studies have not experimented with alternating periods of exposure to wind. In this experiment, I test the hypothesis that brief periods of release from exposure are enough to allow for compensatory growth. *Raphanus sativa* seeds and seedlings were exposed to three separate treatments of no wind, constant wind, and alternating periods of wind and no wind, and stem, root and total biomass were compared between treatments. We found that stem and total biomass in those plants exposed constantly to wind was lower than those not exposed to wind at all and those exposed to alternating periods of wind. There
was no difference in root biomass over treatments, suggesting that there is no compensatory root growth due to wind exposure. There was no significant difference between plants never exposed to wind, and those exposed to wind in alternating periods, suggesting that the brief periods of release from wind exposure were enough for the plants to experience compensatory growth.

**GC-4**

**Fruit dispersal success in *Heteromeles arbutifolia* is better explained by community composition than by fruit display traits**

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Traits like fruit color, nutrition, abundance, and display size, as well as seasonally determined fruiting time have been found to mediate successful animal dispersal in angiosperms. On a larger scale, community structure and composition associated with both plant and frugivore abundances have also been linked to dispersal success. We study the relative importance of community composition and fruit display traits in dispersal. More specifically, we examine how canopy cover and proximity to other plants affects fruit dispersal relative to the effects of fruit cluster size and number. We measured these traits in *Heteromeles arbutifolia* individuals within their native range of chaparral and mixed oak woodland habitats. Canopy cover and mean distance to neighbors were significantly correlated with fruit removal, but fruit cluster size and number were not. Therefore, we concluded that community structure better determines fruit removal for *H. arbutifolia* than fruit display traits and that canopy cover may promote fruit dispersal and successful reproduction.

**GC-5**

**Lack of root architecture change in response to intraspecific belowground competition in *Raphanus sativus***

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How a plant copes with root competition at the seedling stage can determine whether it ultimately survives and reproduces. One means of coping with root competition involves increasing specific root length (root length: biomass). This increases surface area for nutrient absorption as well as the rate at which root depth is achieved. Another potential way to mitigate root competition involves postponing lateral root production until the primary root has reached depths beyond the competitor. We investigated whether *Raphanus sativus* seedlings change their root architecture in these ways in response to conspecific proximity in experimental phytogel plates. We found no evidence for changes in specific root length or lateral root production when seedlings were growing near versus far from conspecifics. Root biomass was also comparable between these treatments suggesting that proximity to conspecifics at small scales may not have increased root competition. Further experiments will clarify whether the previously documented relationships between root architecture and competitor presence in nature are causal.

**GC-6**

**Investigation of Heat Shock Protein 70 in Extremophiles and Mesophiles**

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Extremophiles are organisms that have the ability to live and thrive in extreme environments. Some examples of extreme environments include high or low temperature, high or low pH and high salt.
concentrations. In this study, I investigated Heat Shock Protein 70 (HSP70) in 4 extremophiles and 2 mesophiles. I compared the amino acid sequences of all of the organisms to try to determine whether it is a conserved protein or if it varies by organism or type of environment. In this study, I found the organisms that thrive in higher temperatures had more similar sequences and were more closely related than organism from mesophilic conditions, even if the were technically closely related organisms as was seen with *Naegleria fowleri* and *Naegleria gruberii*.

**GC-7**

**Competition between Blue Oak (**Quercus douglasii**) and Poison Oak (**Toxicodendron diversilobum**) and its effect on recruitment**

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Facilitation from older “nurse” plants allows young plants to succeed in environments they would otherwise be less successful in. Relationships among plant neighbors may exist at a given time at any point along a spectrum, from fully facilitative, to fully competitive. Understanding these relationships may be of benefit for managing struggling populations of late-succession woody plants. Recently these relationships have been examined in the context of management strategies in order to deal with low recruitment rates of woody plants in Mediterranean climates. Based on the results of these other studies, I chose to examine the relationship between *Q. douglasii* and *T. diversilobum* under the experimental hypothesis that the presence of *T. diversilobum* will confer a positive facilitative effect upon *Q. douglasii*. Results obtained in the course of my experiment, however, suggest that the presence of *T. diversilobum* actually had a negative effect on recruitment of *Q. douglasii*. This would put their relationship, at least in a late-succession environment, as one of competition. Further research into this relationship with regards to time since disturbance would likely show a relationship that changes as the community moves through successional stages.

**GC-8**

**Investigating the Effects of Fire on **Centaurea solstitialis** (Yellow Starthistle) Seed Viablitiy**

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The introduction and spread of invasive species has become a serious problem throughout the world. *Centaurea solstitialis* (Asteraceae) is an invasive plant that has infested around 5.6 million hectares in California. It spreads by wind dispersed achenes and has the ability to out-compete native plant species for light, space, and nutrients. Controlled burns in infested grasslands have been used as a control method for this invasive plant. The land managers of Upper Bidwell Park in Chico, CA carried out a controlled burn in a grassland infested with *C. solstitialis* in July of 2011. We conducted research to examine the effectiveness of the use of fire to control the spread of *C. solstitialis*. We analyzed soil pH, post-burn seed viability, and changes in community composition in a burned and unburned grassland in Upper Bidwell Park. Plant diversity and evenness were found to be relatively similar. The soil pH was neutral (7.0) at both sites. The burn experiment results showed that seed germination of *C. solstitialis* is negatively affected by fire.
GC-9
Photosynthetically Active Radiation (PAR) does not affect Sierra Fawn Lily (*Erythronium multiscapoideum*) fitness
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Competition for Photosynthetically Active Radiation (PAR) has been defined as a mechanism that can reduce plant fitness. PAR competition can also result in the extirpation of some plant species to less nutrient available soil groups such as serpentine. While previous studies have focused on differences in fitness of a plant species on and off serpentine soils, reproductive allocation response due to varying PAR levels within a plant species growing on serpentine soils has received little attention. I hypothesized that PAR level would have an effect on reproductive allocation in the serpentine endemic, *Erythronium multiscapoideum*. I predicted that under lower light conditions that plants would channelize energy to reproductive traits to improve their relative fitness.

PAR levels were measured at 0900, 1200, and 1500 on a sunny, clear day in April 2012 in Magalia, California along a 150 m transect with varying PAR levels. Sixty-four *Erythronium multiscapoideum* plants were measured for leaf length, corolla diameter, and pollen-stigma counts. Linear regression analyses between plant traits and PAR level or between vegetative and reproductive traits showed that there were no significant relationships among these variables. Specifically, pollen counts compared to daily PAR values, leaf lengths, and corolla diameters produced a p-value of 0.649 and R-square of 0.02684. Improved fitness through reproductive allocation with corresponding changes in PAR levels on serpentine soils was not supported by this study.

GC-10
Cattle grazing disturbance effects on plant diversity in California vernal pools
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Human-mediated disturbance is believed to have a negative effect on the diversity of plant communities. Cattle-grazing is a type of disturbance that often occurs in California’s vernal pools. The quantity and frequency of grazing can determine the magnitude of the effect and a moderate amount of grazing has been demonstrated to stimulate plant growth. Vernal pools are a sensitive wetland habitat which contain high species diversity and endemism due to extreme environmental conditions. At Vina Plains Preserve (Tehama County, California), I tested the hypothesis that cattle grazing is negatively correlated with plant diversity. I examined the degree of grazing disturbance and plant diversity in 21 vernal pools, comparing the presence/absence of plant genera to the proportion of bare ground around each pool. Mean values of disturbance level and presence/absence data were calculated from collecting multiple sampling points within a pool. A simple linear regression model demonstrated a slight negative correlation between grazing and plant diversity, but the data do not support my hypothesis for a negative effect of grazing on plant diversity (p = 0.5461, r^2 = -0.0326).

GC-11
A Genetic and Transcriptomic Analysis of Retinitis Pigmentosa: Rod-Cone Dysplasia Type 3 Presence and Isolation in Cardigan and Welsh Pembroke Corgis Dog Breeds.
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Retinitis pigmentosa is a genetic eye disease that affects humans and other animals. There are many types of retinitis pigmentosa that result from different gene mutations. One form is rod-cone
dysplasia type 3 (rcd-3) which affects Cardigan and Pembroke Welsh Corgis. rcd-3 is caused by a
single adenine deletion in PDE6A gene (a-subunit of cyclic guanosine monophosphate (cGMP)
phosphodiesterase). The deletion results in a frame shift and forming of premature stop codon
during PDE6A synthesis. In this study I investigated several animals and compared PDE6A proteins
using ClustalW2. I found that PDE6A is highly conserved in animals. Based on this conservation I
hypothesized that the same mutation that causes rcd-3 in corgis can also be found in other animals. I
investigated PDE6A variations, using online databases, and compared them to the mutation that
causes rcd-3 and found no similarities. Though retinitis pigmentosa affects many animals, rcd-3 is a
distinct form in corgi breeds.

GC-12
No allelopathic effects of *Raphanus raphanistrum* (Brassicaceae) on seed germination of
*Eschscholzia californica* (Papaveraceae)
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BIOL 672

Many members of Brassicaceae have been shown to produce allelopathic chemicals. Secondary
compounds can help defend plants from herbivory, pathogens, and other plants. One member of
Brassicaceae that has been shown to produce the secondary compound glucosinolate is *Raphanus
raphanistrum*. The main question behind this study is whether or not the secondary compound
produced by *R. raphanistrum* inhibits seed germination of the California native plant, *Eschscholzia
californica*. To investigate this question, I compared germination of *E. californica* in soil collected
from the rhizosphere of *R. raphanistrum* to that of soil collected away from *R. raphinistrum*
populations. I found no significant difference in germination of *E. californica* grown in radish soil
versus non-radish soil. The hypothesis that the secondary compounds produced by *R. raphinistrum*
inhibit seed germination of *E. californica* was not supported in this study; instead the findings
reinforce the complications associated with testing the allelopathic potential of plants.
Graduate Research

GR-1
Leaching and decomposition of leaf litter in water of an acidic geothermal lake
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Boiling Springs Lake (BSL) is an acidic geothermal lake in Lassen Volcanic National Park. BSL is oligotrophic, and it is unclear what carbon sources are available to microbes. Leaves from the surrounding trees (pine, cedar, and manzanita) might be a potential carbon source for the microbes, but little is known about the contributions of leaf litter to microbial production in geothermal, acidic environments. In this study, I measured the loss of dry mass of leaves incubated in BSL water under different conditions. Loss of mass includes both a leaching phase, dominated by chemical release of soluble oligomers, and decomposition, dominated by microbial colonization and breakdown of polymers. Compared to other studies using similar leaf types in non-thermal, neutral waters, rates were similar, and experiments with filtered vs. unfiltered water suggested that microbes associated with leaf surfaces contribute significantly to breakdown of leaf matter in the lake. These data suggest modest contributions of allochthonous litter to the C cycle of Boiling Springs Lake.

GR-2
Glutamate and Potassium Chloride Induced Excitotoxicity: FVB/N and C57BL/6 Mice Contain Different Concentrations of Calcium Impermeable GluR2 AMPA Receptors
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Glutamic acid (Glu) is an excitatory neurotransmitter in the brain that binds to ionotropic Glu receptors located in the postsynaptic membrane and allows calcium into the cell. Elevated levels of Glu can induce excitotoxicity (seizure), resulting in high intracellular calcium, which disrupts mitochondrial function and leads to cell death. It has been shown in vitro that FVB/N (FVB) mice are susceptible to Glu-induced excitotoxicity while C57BL/6 (B6) mice are resistant. I hypothesize that FVB and B6 mice contain different concentrations of calcium impermeable GluR2 subunit-containing AMPA receptors (GluR2-AMPARs). In order to determine whether GluR2-AMPARs play a role in susceptibility, two excitotoxic treatments were used. Glu was used to stimulate GluR2-AMPARs, while potassium chloride (KCl) was used to bypass Glu receptors and depolarize the cell via voltage-gated calcium channels. Additionally, Cyclosporine A (CsA) is neuroprotective against excitotoxicity in rats and FVB mice. Therefore, various concentrations of CsA were used to determine changes in susceptibility in both strains. Neuronal viability was measured using a viability assay and analyzed. Results showed that both FVB and B6 strains resulted in cell loss after KCl-induced excitotoxicity. FVB neurons treated with Glu alone resulted in significant cell loss, while neurons pretreated with CsA were resistant to Glu excitotoxicity (viability wasn’t different from controls). B6 neurons treated with Glu alone didn’t show any significant cell loss, but showed a decrease in viability with increase in CsA concentration. These data support my hypothesis and suggest that something beyond the GluR2-AMPARs might be responsible for regulating excitotoxicity.
GR-3
“Hands-on, minds-on” 3rd grade module: Life history and population ecology of turtles
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We present a teaching module aligned to California Education and the Environment Initiative that teaches population ecology to 3rd grade school children with a focus on the environment using hands, on, minds-on methods. We used ongoing research, focusing on California’s native Western Pond turtle (Emys marmorata), to inform a “hands-on, minds-on” module teaching grade school focused on population ecology and the scientific method, including an emphasis on the importance of practical math skills to preserve our natural resources. Our teaching modules took place in an ‘Outdoor Classroom’ on the Big Chico Creek Ecological Preserve, where children learned about turtle trapping, marking, and long-term population data collection, in addition to engaging in discussions about the biology of E. marmorata and potential threats of invasive turtle species. Based upon hand-written thank you cards and assessment results, we conclude that children came away from these education sessions with a new appreciation for a native reptile, an understanding for the life requirements of this animal, and how these needs can be impacted by non-native fauna, in addition to insight into why and how research is conducted. Complete teaching materials will be provided in the appendices for other outdoor educators and grade school instructors to download, adapt, and use for their purposes when this material is published in an open source science teaching journal.

GR-4
Growth and carbon utilization of hot springs fungi
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Fungi are important degraders of plant biomass making them targets for biofuel production. However, current conversion of lignocellulose to ethanol requires pre-treatment under warm, acidic conditions not suitable to most commercial fungal enzymes. I am characterizing the decomposition abilities of seven ascomycetes fungi associated with Boiling Springs Lake, a hot, acid environment for biofuels production. Due to these naturally occurring conditions, I hypothesized these fungi isolates produce thermal/acidic stable enzymes. As part of this characterization, I am screening for degradation of plant cell wall carbohydrates sources (cellulose, cellobiose and hemicellulose) under warm and acid conditions. Preliminary growth assays at 36°C, at both pH 7 and pH 2.2, show six of the seven isolates produce greater conidia formation and hyphae growth on cellobiose and hemicellulose compared to no carbon controls. I am also characterizing growth over a temperature gradient: 25-51° at pH 2.2. So far, two isolates, Ochroconis sp. and Acidomyces sp., are capable of growth up to 44°C.

GR-5
Courtship of Northern pintail in relation to sex ratios, pairing chronology and hunting pressures: Preliminary Data
Stevie Foster, stevieroxelle@gmail.com Don Miller, dgmiller@csuchico.edu

In studying animal populations of special interest to management, understanding the factors affecting mating and reproduction can be very important. Northern pintail (Anas acuta) is a North American duck with population levels that were below projected numbers until recently, and researching some of the mechanisms leading to pairing and mating can help managers regulate the population. In my study, I research a number of different variables and their potential effects on
pairing behavior of Northern pintail. Here I present the data collected in my first year of research, from October 2010 to February 2011. To understand trends in changing courtship flight size, I compare this variable to pairing status of females, sex ratios, and hunting pressures over time. From these preliminary results, it appears that pairing status of females has the strongest relationship to courtship flight size, which indicates that courtship flight size is determined by the decreasing number of females available for pairing in the population. Hunting pressure seems to have little effect on courtship flight size, suggesting that hunting has little effect on courtship behavior.

GR-6
Assessing Ecological Recovery in Montane Sierra Nevada Montane Meadows
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Montane meadows in the Sierra Nevada are biodiversity hot spots for plant communities and can thus provide a variety of resources including wildlife habitat. These meadows also play an important role in filtering snowmelt to provide an important source of water for both wildlife and Californians. Combinations of meadow importance and degradation through human disturbances have led park managers and scientists to implement restoration efforts to improve hydrologic connections and biotic health within these meadows.

My thesis is evaluating the ecological status of less-disturbed, disturbed and restored montane meadows in the Sierra Nevada. Less-disturbed meadows in Yosemite National Park will provide a reference for assessing the ecological integrity of the restored and disturbed meadows in Big Trees State Park watershed. I am documenting hydrologic connectivity and plant community composition, emphasizing species diversity and invasive species extent, across this disturbance gradient.

Understanding how meadow plant communities correlate with hydrologic changes and site status in Sierra Nevada montane meadows is important for current and future management decisions for restoration and conservation initiatives.

Preliminary results suggest richness values are relatively similar. However, less disturbed meadows have an overall lower number of non-native and invasive plants (NN = 5.4%, I = 5.4%) than restored (NN = 9.3%, I = 1.3%) and disturbed sites (NN = 18.5%, I = 13.8%) and thus higher overall percentages of natives. Further analysis will indicate relative abundances of these non-native and invasive species within these meadows and allow for a better understanding of the ecological status of these sites.

GR-7
Evaluating vernal pool restoration for two rare grasses, *Neostapfia colusana* (Colusa grass) and *Tuctoria greenei* (Greene’s tuctoria)
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Vernal pool habitats and associated plant and animal taxa have been significantly reduced by conversion to agriculture and urbanization. As a result, a number of vernal pool dependent species have become rare and extirpated both locally and range-wide. This is true for several endemic vernal pool plants including *Neostapfia colusana* (Colusa grass) and *Tuctoria greenei* (Greene’s tuctoria). Building upon previous conservation research on these two grasses, the goal of my research is to examine the potential for introductions of the rare grasses into vernal pool habitats. To this end, I have established four study sites, two sites with restored vernal pools and two reference sites with extant populations of the rare grasses. During spring and summer 2010-2011, I documented vegetation associates, dry down hydrology, and Colusa grass and Greene’s tuctoria population.
locations to compare and inform introduction success. In January 2011, I introduced Colusa grass and Greene’s tuctoria into the restored pools and, for comparison, reintroduced the grasses into the reference pools. I monitored the four sites collecting germination, survivorship, and reproduction information. Preliminary results show a range of 5-70% germination at the four sites. Greene’s tuctoria introduction at the restored site was promising, with upwards of 60% of germinated seeds producing an inflorescence. Monitoring of second generation in 2012 will help assess persistence. The results of this research are imperative in informing restoration efforts for Colusa grass and Greene’s tuctoria populations as well as for other rare vernal pool plants.

GR-8
Research on the Ecology and Life History of a Rare California Endemic Mint, Monardella venosa
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Rare species can play important roles in the maintenance of ecosystem processes and their associated ecosystem goods and services on which humans rely for their well-being. Conservation of a rare species requires a thorough understanding of how the taxon functions at the individual, population, community and ecosystem levels. This research asks questions pertaining to the life history and ecological interactions of the Butte County population of the rare California edaphic endemic plant, Monardella venosa.

Although field observations indicate a strong affinity of M. venosa to the visually distinctive patches of soil where it currently grows, greenhouse and field experiments did not identify any significant fitness benefit provided by these soils. Analysis of the overall reproductive success of this population of M. venosa found the mean seed-ovule ratio to be less than half of maximum. To assess the effect of invasive species on the reproduction and growth of M. venosa, a split-plot design consisting of invasive removal and control sub-plots was implemented. M. venosa growing in invasive removal sub-plots grew significantly slower but achieved approximately double the stem mass and reproductive output than plants in control sub-plots. The contrasting pattern of faster growth but lower reproductive success of plants in control sub-plots points to competition for light resources as the mechanism driving this interaction. These results provide insights to the factors naturally limiting and threatening the persistence of M. venosa in Butte County. This information can guide management actions which assure the persistence of both Monardella venosa and its natural community.

GR-9
Quantification of Gene Expression of Proteins Associated with Neutral Lipid Synthesis in Emiliania huxleyi
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Emiliania huxleyi is a marine haptophyte that produces novel C_{37-39} PolyUnsaturated Long Chain Alkenes, alkenones and alkenoates (PULCA) as neutral lipid. These lipids are sequestered in lipid bodies, and may have potential as a biofuel, but their biosynthesis is still poorly understood. I am using Quantitative PCR (qPCR) to determine expression of genes that might be related to neutral lipid biosynthesis, based on proteins previously identified in a lipid body proteomics screen (Wolfe, in preparation). I examined E. huxleyi CCMP 1516 grown in batch culture, including both conditions of neutral lipid accumulation, as well as lipid catabolism. By comparing lipid quotas (measured by Nile Red fluorimetry) with patterns in gene expression, I am testing proposed biosynthetic pathways.
Microwave-assisted transfection technique increases efficiency in short-term transfection

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Transfection is a method to deliver DNA or RNA into cells. In cellular and molecular research, this technique is used to express specific proteins from artificial DNA often containing fluorescent protein genes, in target cells and also can be used to inhibit a target gene using siRNA transfection. Several transfection methods have been established. A better understanding of transfection methods would improve transfection efficiency and further benefit cellular and molecular biology research. In our previous research, we improved immunolabeling and reduced the amount of time with a microwave-assisted procedure. In this study, we tried to find the optimum protocol for a microwave-assisted transfection. The pEGFP plasmid was transfected into INS-1 cells using TransIt-LT1 transfection reagent and a variety of microwave exposure times. This is preliminary data, but we improved the transfection efficiency of the microwave-assisted transfection so that it more than twice the control. Overall, our results show that the microwave-assisted transfection technique successfully increased efficiency for short term transfection procedures. However, we did not observe any differences during long term transfection procedures.

Support for the Accumulated degree-day hypothesis for decomposition on exposed carrion in the California Central Valley using Sus scrofa

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Significance: The mix of open fields and forested areas present in California’s Central Valley presents challenges for medico-legal investigators. Human remains are often found in advanced stages of decomposition, so an important component of forensic investigations is estimating the post mortem interval (PMI) of the deceased.

Experimental Hypothesis: The goal of this field study was to test the validity of the techniques used by Megyesi et al (2005) in which Total Body Score (TBS) and Accumulated Degree Days may be used retroactively to determine the PMI on a given set of remains in a Mediterranean climate where animal scavenging was not a variable.

Methods: The pig carcasses (Sus scrofa domestica) obtained from the University of California, Davis, Animal Research Center, were placed in direct contact with the ground and covered by a wooden and wire cage to inhibit larger scavengers (e.g. coyotes) from disturbing them. A weather station was placed on site to record precise average daily temperatures, average humidity as well as daily total precipitation.

Preliminary Results: Previous experiments in temperate and subtropical climates have shown that unknown ADD could be estimated using TBS by using the formula: Log10 = 0.002(TBS*TBS) + 1.81. While additional replicates in my field study will be required to determine if this is also true in a Mediterranean climate, the initial data taken does for now lend support this hypothesis.
GR-12
Determining migration patterns using Geolocators on Male Flammulated Owls (*Otus flammeolus*) from Two Breeding Sites in Washington and Utah
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Flammulated owls (*Otus 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 and Central America. They are cryptic and elusive cavity nesters and little is known about their basic biology including migration patterns. They are potentially a Species of Concern for the U.S Fish and Wildlife Service because of potential habitat destruction. The goal of this thesis project is to use a device called a geolocator to track the movements of these owls during their migratory season. The geolocator records light levels that correspond to sunrise and sunset times that can then determine specific bird locations. 20 geolocators will be attached to male owls at two sites in Washington and Utah, with males being targeted because of greater site fidelity than females. We will return to the breeding sites in the summer of 2013 to retrieve as many geolocators as possible and use the geolocator information to map the migratory behaviors of this owl species. This geolocator study will be the first step in assessing the current status of this species with the goal of a broader western US effort to follow in the future.

GR-13
Food Availability for the Yellow-billed Cuckoo along the Sacramento River
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In the western U.S. the yellow-billed cuckoo was once common, ranging from British Colombia to Northern Mexico. The conversion of mature riparian forests to farmland in the early 20th century contributed to the drastic decline of the species in the west. For example, along the Sacramento River, populations have declined by 70 percent in the last 40 years from an estimated population of 250 individuals to 35-70 individuals in the most recent survey. The Sacramento River population is of particular interest as it represents the largest remaining population in California. Population numbers have not increased in spite of concerted efforts to restore cuckoo habitat along the Sacramento River, there is a pressing need to better understand why population numbers remain low. The goal of this research is to test the hypothesis that the prey base differs significantly between restored riparian habitats occupied by the species versus similar habitat that remains unoccupied.

In the 2011 field season, five cuckoos using two territories were located in 12-year old restored riparian forest. Insects were collected from these sites and two control (non-detection) sites using three different methods (branch clipping, malaise trapping, SLAM trapping). Preliminary evidence suggests that detection sites contained higher abundances of potential prey compared to non-detection sites. This study is the first detailed prey availability study for yellow-billed cuckoos, and could help us better understand why this species continues to decline along the Sacramento River.
Characterizing migration patterns, winter habitat and diet of Northern Saw-Whet Owl (*Aegolius acadicus*) in the Sierra Nevada Foothills of California

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Northern Saw-Whet Owls (NSWO, *Aegolius acadicus*), one of the smallest raptor species in North America, migrate in large numbers every fall from Northern latitudes, including Big Chico Creek Ecological Reserve. Recent efforts to characterize their migration and destination using mist-netting and radio-telemetry techniques revealed that some NSWO overwinter locally at BCCER, while others continue migrating to yet unknown winter habitats. This study’s goal is to identify critical winter habitat and prey of NSWO by radio-tracking individuals to their diurnal roost sites, assessing the vegetation they are using, and analyzing their pellets for prey species being taken. From two seasons of radio-tracking sixteen total NSWO to 137 roost sites, this study has revealed a preference for the tree species Canyon live oak (*Quercus chrysolepis*) and shrub Toyon (*Heteromeles arbutifolia*), with roosts averaging 11.8 (±9.57) meters when in *Q. chrysolepis*, and 1.36 (±.64) meters in *H. arbutifolia*. Preliminary diet analysis shows a majority of pellets containing remains from multiple individuals, including *Reithrodontomys megalotis*, *Microtus californicus*, and *Peromyscus* species. A third field season is planned for the fall of 2012, with the intent to radio-track 6 more NSWO and further identify the important wintering vegetation required for this species to successfully overwinter.

Neutral Lipid Production in The Marine Haptophyte *Emiliania huxleyi*

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*E. huxleyi*, a globally important coccolithophorid, synthesizes an unusual set of PolyUnsaturated Long-Chain Alkenones, Alkenoates, and Alkenes (PULCA) as its neutral lipids, which are stored in lipid bodies similar to the triacylglycerols produced by most other algae. These C37-39 hydrocarbons with 2-4 trans-alkene bonds occurring at 7-carbon intervals are structurally attractive as a possible biofuel. However, little is known about their biosynthesis. Here, I monitored carbon flow into PULCA stores using radiotracers. Stationary phase cultures of strains CCMP 1516 and 371 were pulse- and pulse-chase-labeled with either C-14 bicarbonate or U-C14-acetate, and movement of the label through the cell and into lipids was monitored over a period of 24 hrs during a light-dark cycle. I also identified neutral lipids produced in *E. huxleyi* strains: CCMP 1516, CCMP 371, 3266, and 3268 using gas chromatography-mass spectrometry (GC-MS) analysis. Based on this information I then performed a more detailed analysis using GC-MS of nonpolar lipid production in *E. huxleyi* strains CCMP 1516 and CCMP 3268 in response to stress. Results from radiotracer experiments show that acetate incorporates predominantly into polar lipids (phospho- and glycolipids), while bicarbonate distributes almost equally into polar and neutral lipid stores. Results from GC-MS work show that *E. huxleyi* strains CCMP 1516, CCMP 371, and 3266 produce mostly C31 cis-alkenes, while CCMP 3268 produced mostly C37 trans-alkenes. Cells grown in excess bicarbonate showed a dramatic increase in lipid production. These results support a biosynthesis model for PULCA involving fatty acid synthesis components from both plastidial and cytoplasmic locations.
Many rare and threatened California plant species are endemic to ultramafic serpentine soils. Understanding what specifically makes these species rare is of high value to conservation and management efforts statewide. While there is no one definition of what makes a plant rare, there are many characteristics that are thought to contribute to a species’ rarity. My study focuses on environmental and reproductive attributes of a rare serpentine endemic to evaluate their contribution to the plant’s rarity. Packera layneae, or Layne’s Butterweed, is a federally threatened and state listed rare species occurring in small, fragmented populations on serpentine soils in the northern California Sierra Nevada. The goals of my study are four-part: to determine what environmental factors characterize the habitat of this species; to evaluate seed dispersal success; to evaluate seed viability through germination and seed bank studies; and to create a species distribution model (SDM). Environmental data including associate species is being collected by in-field surveys. Seed dispersal distance was evaluated using in-field arrays. Seed germination in multiple media is being conducted under controlled conditions. Soils collected in-field are being grown-up to determine seed bank presence/absence. The SDM employed is Maxent, which is proficient in modeling rare species, even when presence data is minimal. It uses presence locations in combination with environmental layers (elevation, aspect, slope, soil type) to produce a predictive output map for the species. Determining why this species is so patchily distributed and understanding its unique habitat requirements will be vital to its conservation and long-term success.

Geographically isolated habitat is of special concern due to the potential for speciation or extinction over time. The Sutter Butte mountains of northern California represents unique possibilities for studying geographic isolation. The location of this mountain range is peculiar because it stands alone in the northern Sacramento River valley, surrounded by flatlands in all directions. These contrasting habitat types could deter animal migrations to and from the Sutter Buttes, creating isolated populations. Instances of geographic isolation in this range have already been documented, including the sagebrush lizard whose population in the Sutter Buttes exists well below the expected elevation for this species. My research will utilize venom protein characteristics to determine whether the northern Pacific Rattlesnakes (Crotalus oreganus) of Sutter Buttes are geographically isolated. These venom characteristics have been shown to adapt to environments relatively rapidly. My research will use a method of chemical analysis to determine if and to what degree these snakes are isolated.
Evaluating Fluctuating Asymmetry as a tool for Conservation of the Western Pond Turtle (*Emys marmorata*)

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Turtle shell ventral morphological characters (gular and humeral scutes) were measured to determine if fluctuating asymmetry (FA) was present. We compared turtles from populations with minor human modifications, Big Chico Creek Ecological Reserve (BCCER), Butte Creek Ecological Preserve (BCEP) to a site with major human modification Chico Wastewater Treatment ponds. Over the course of two collection seasons (2010-2011) the scute circumferences from a total of 228 turtles were measured.

Turtles with high FA were expected to be located in areas of high human modification (suspected high stress). In this study of three isolated populations of *Emys marmorata*, in northern California, the above-expected hypothesis was not entirely confirmed.

FA measurements of **gular** scutes in this study partially supported the “modified site” hypothesis:

1. The percent differences of gular measurements (FA) for females were larger at the wastewater site than at BCCER.
2. Males showed a similar pattern in which the percent differences of gular measurements from the wastewater site are larger than gular measurements from the BCCER and the BCEP.
3. Female gular measurements from BCEP suggested no differences between BCCER and wastewater sites.

FA measurements of **humeral** scutes did not support the hypothesis:

1. Female humeral measurements from the BCEP were larger than measurements from BCCER and the wastewater site.
2. Humeral measurements from BCCER and the wastewater site were nearly equal.
3. Male humeral measurements from the BCCER were larger than measurements from both the BCEP and the wastewater site.

Does a knockout of the Msx2 regulatory gene in mice alter their lymphocyte population?

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The Msx2 gene has been widely studied and is known to be of integral importance in early development. Specifically, this gene is important in the development of cranial bones, the upper and lower jaw, and other bone formations as well as ectodermal organs including the teeth, hair, and mammary glands (Wuyts et al, 2000/Ichida et al, 2004). In 2003 (Twizere et al., 2003), it was discovered that the Msx2 gene is also expressed in lymphocytes. To determine possible functions for the expression of this regulatory gene in lymphocytes, we examined the effect on the lymphocyte populations of knockout mice missing the Msx2 gene. Wright’s staining was performed to numerically compare lymphocyte populations to other mononuclear cell populations. We found that in the knockout mice the number of neutrophils increased, while the number of lymphocytes decreased. To measure any changes in lymphocytes in the knockout mice, CD-19, CD-5, and Thy-1 cells were fluorescently tagged and numerical data on the quantity of these cells was obtained. CD-
19 and Thy-1 cells showed no numerical differences in the knockout mice, while CD-5 cells were decreased, indicating fewer B1 cells are produced in mice lacking the Msx2 gene. These results imply that the Msx2 gene does play a role in regulating lymphocytes.

GR-20
Distribution and Conservation of Reduced P Metabolism Operons In Bacteria.
Student: Betsey Renfro (Thesis research)
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Despite much indirect evidence of bacterial mediated redox cycling of P, only four bacteria involved in these processes have been thoroughly characterized. To add to our understanding of this environmentally significant process, I identified the Phosphite oxidation pathway in *Pseudomonas putida*, a common soil bacterium that was isolated based on its ability oxidize hypophosphite and phosphite for use as a sole P source. Using heterologous expression of *P. putida* chromosomal fragments in *E. coli*, the *P. putida* phosphite oxidation pathway was determined to be comprised of 5 genes, *ptxABCDE*, which are almost identical to those of the previously characterized *P. stutzeri*. I also verified that *P. putida* has the same hypophosphite oxidation gene, *htxA*, that has been characterized previously. This demonstrates that these genes are important and potentially transferred by horizontal gene transfer among environmental bacteria. To determine the distribution and conservation of reduced P oxidation pathways among bacteria, I searched metagenomic sequences and sequenced organisms for Hypophosphite, Phosphite and Phosphonate degradation pathways. I found limited distribution of the *htxA* gene with the majority of the sequences being from marine metagenomic samples. However, three identical *htxA* sequences were found which suggest recent horizontal gene transfer. Approximately 65 organisms with Phosphite metabolic pathways were identified. The organization of this pathway was highly conserved and the genes were frequently associated with transposases. However, the organisms possessing this pathway were primarily limited to proteobacteria, cyanobacteria and metagenomic sequences. The Phosphonate pathway was widely distributed, with over 250 organisms identified. These organisms were distributed between 5 different phyla of bacteria and archaea. Together, this data suggests that the oxidation of reduced P compounds is a common pathway in bacteria and provides support for the presence of a P redox cycle.