

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Natural Resource Management and Environmental Sciences in the Great Basin and Sierran Ecosystems

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			13%	
103	Management of Saline and Sodic Soils and Salinity			2%	
111	Conservation and Efficient Use of Water			5%	
112	Watershed Protection and Management			12%	
121	Management of Range Resources			31%	
122	Management and Control of Forest and Range Fires			2%	
123	Management and Sustainability of Forest Resources			1%	
125	Agroforestry			5%	
132	Weather and Climate			1%	
133	Pollution Prevention and Mitigation			13%	
135	Aquatic and Terrestrial Wildlife			2%	
136	Conservation of Biological Diversity			2%	
211	Insects, Mites, and Other Arthropods Affecting Plants			10%	
216	Integrated Pest Management Systems			1%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.9	0.0
Actual Paid Professional	0.0	0.0	6.5	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	490183	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	686973	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

To address these critical issues, NAES research will be conducted on evaluating long term vegetation changes in the Great Basin, measuring heavy metal contamination in Nevada's waterways, pheromone protection of forests, evaluating livestock grazing for noxious weed management, compatibility of wildlife and livestock grazing, evaluating post wildland fire restoration and grazing systems, evaluating forest wildfires and ecosystems recovery, studying soil transport properties using NAES field labs to conserve water and improve water quality and evaluating sage grouse and pygmy rabbit habitats and developing a conservation plan compatible with Nevada agriculture.

2. Brief description of the target audience

The target audiences for research and educational programming are livestock producers, veterinarians, environmentalists, local governments, native american groups and agency personnel.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1026	0	1366	150

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2012
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	0	49	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Peer reviewed scientific publications, publications in natural resource and environmental organization publications, presentations at scientific meetings, presentations at stakeholder, Native American and agency meetings.
Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Demonstrations, Field Days, and Workshops Conducted

Year	Actual
2012	14

Output #3

Output Measure

- Newsletters Produced

Year	Actual
2012	3

Output #4

Output Measure

- Leveraged Research Projects

Year	Actual
2012	3856792

Output #5

Output Measure

- Web Sites Created or Updated

Year	Actual
2012	8

Output #6

Output Measure

- Manuals and Other Printed Instructional Materials Produced

Year	Actual
2012	2

Output #7

Output Measure

- Number of Graduate Students or Post-Doctorates Trained

Year	Actual
2012	12

Output #8

Output Measure

- Number of Undergraduate Students Involved in Research

Year	Actual
2012	73

Output #9

Output Measure

- Non-peer Reviewed Publications

Year	Actual
2012	99

Output #10

Output Measure

- Presentations

Year	Actual
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2012

98

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Peer reviewed journal articles, presentations at scientific meetings, articles in natural resource and environmental science magazines, presentations at stakeholder, Native American and agency meetings.
2	Unraveling Insect Hydrocarbon Production
3	Castle Lake Long Term Research Program
4	Persistence of Native Grasses in Cheatgrass Invaded Ecosystems
5	Developing a Better Understanding of Nutrient Transport in Sierran Watershed Soils
6	Sagebrush Demography and Climatic Controls in Nevada's Semi-arid Ecosystems
7	Hydrologic and Vegetative Response to Pinyon-Juniper Treatments at the Watershed Scale
8	Synergistic Monitoring for Adaptive Vegetation Management in the Sagebrush Ecosystem of the Great Basin
9	Pheromone Control of the Invasive Bark Beetles

Outcome #1

1. Outcome Measures

Peer reviewed journal articles, presentations at scientific meetings, articles in natural resource and environmental science magazines, presentations at stakeholder, Native American and agency meetings.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Unraveling Insect Hydrocarbon Production

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Hydrocarbons are important component of the insect outer surface, keeping the moisture in and nature out and, in addition, serve critical roles in chemical communication. A good analogy is the wax on a milk carton, without it, your carton leaks. Thus, if you can prevent the formation of these hydrocarbons, the insect will desiccate and die. The control over this process could lead to a novel method for dealing with insect infestations. In addition to creating targets for pest insect management, these genes may also be applied to biofuel (hydrocarbons) production in algae or plants.

What has been done

This year has been a breakthrough year. For the past 17 years, the University of Nevada has been chasing an enzyme that controls aldehyde and hydrocarbon production. Through a long series of experiments, the team has finally characterized the gene, a CYP4G2 family cytochrome P450 enzyme. Once characterized, the gene was then located in drosophila (fruit flies) and silenced. The results from the drosophila trials provided further evidence that CYP4G2 controlled hydrocarbon production in insects, while also reducing courtship behaviors. Through another series of experiments, CYP4G2 enzymes were then introduced to aldehyde with radioactive

markers built in. The results, the gene produced radioactive hydrocarbons. These findings were published in the third most prestigious journal in the world, "Proceeding of the National Academy of Science".

Results

The work reported to the National Academy of Science has already been shown to increase the stock of useful knowledge by the sheer number of citations received. This project has created an international network of scientists all now working to better understand insect management through aldehyde and hydrocarbon control. Over the past year, the UNR team has now trained three graduate students, one of which is starting her own biotech company.

One future goal of the team involves the commercial production of hydrocarbon as biofuel. Of all the biofuels under development, hydrocarbon based biofuels are superior because they have high energy density, can be transported by pipelines, and are compatible with existing engines. If the team can transfer these genes into other organisms (e.g. algae), one could envision plants optimized to produce hydrocarbons.

4. Associated Knowledge Areas

KA Code	Knowledge Area
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
125	Agroforestry
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #3

1. Outcome Measures

Castle Lake Long Term Research Program

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Aquatic ecologists have long been interested in understanding the drivers of ecosystem production (i.e. algae, fisheries etc.) and keeping mountain lakes clear and pure. It is clear that manipulations of the food web through introductions of fisheries along with the drivers of climate (e.g. temperature, snow deposition, an ice) can impact ecosystem production and clarity. The interplay of these factors (climate and fisheries) however is not well understood largely due to the paucity of long-term data and models that calculate these interactions.

We have determined that climate and stocked fish population act as key drivers of annual primary productivity in Castle Lake. Additionally, annual stocking practices appear to be correlated with decreased density and altered species composition of emerging aquatic invertebrates subsidizing the riparian and terrestrial food webs.

The objective of this proposal is to expand these efforts and create a refined model that can be used a template for other mountain lake ecosystems in the Sierra and the Great Basin. These ecosystems are likely exhibiting similar impacts due to climate and fisheries introductions from the state and federal agencies. If the relationship of these patterns can be elucidated through long-term data collections at Castle Lake then we hope to create basic models controlling production (e.g. algae, fisheries, etc.) for each mountain lake ecosystem of interest in the Sierra and Great Basin.

What has been done

UNR has taken the lead for the past 8 years of the 54 year history of data collection at Castle Lake. The major achievements thus far centered around the development of two computer simulation models. Our team has determined that the growing season (from ice out to ice over) is staying consistent over time. California's Governor Office is very excited about this information. Combining this information along with consistent snow pack suggests that there is some resiliency in the landscape. And our models suggest that this is probably due to close proximity to Mt. Shasta.

Another finding is that biodiversity of the lake is shifting. Prior to 1988, climate change was driving biodiversity. 1988 through 1994 a long drought occurred, plus the addition of fish stocks took place, shifting Castle Lake's algae production. This shift has taken over 20 years to recover. This is information that managers need, because they assume that things return to normal in just a few years.

Results

The scientific impacts of this long-term monitoring project are of the utmost importance to all alpine lakes long the Sierra Nevada and Cascade mountain ranges. Now that the University of Nevada is directing the field station, this field station will continue to be the longest running monitoring project in North and South America. In order to preserve these import resources, the UNR team has taken the opportunity to involve not only the state and federal agencies that manage these areas, but stakeholder groups and local communities. Each year the team host a Children's Science Day that is focused on teaching best management practices, monitoring techniques, and watershed health indicators. One new outcome since UNR's involvement, ties the California Department of Fish and Wildlife's management of its alpine fisheries, to those of the USFS efforts in managing for an endangered bat that utilizes these watersheds. Without a clear understanding of how fish stocking rates influence the overall food web, one agency could have unknowingly been impacting the other's efforts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
132	Weather and Climate
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #4

1. Outcome Measures

Persistence of Native Grasses in Cheatgrass Invaded Ecosystems

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

An increased demand for use of local native grasses in restoration has led restorationists to consider the genetic integrity of native seed sources. Currently, restoration in the Great Basin is implemented using agricultural seed that is produced for a wide range of locations. Plants that have been produced commercially are provided ample amounts of nutrients and water, all of which do not reflect the natural environmental conditions (precipitation, soil composition, climate, etc.) of the various locations where the seed will eventually end up for restoration. These and other "unnatural pressures" (harvest techniques, etc.) create genotypes that may not be adapted to their environmental restoration locations. This research has important implications for improving current restoration practices in the Nevada's Great Basin.

What has been done

In collaboration with USDA-ARS Reno, the UNR team measured seedling establishment of native perennial grass species and address whether these species were evolving to become more competitive with cheatgrass. The team developed and used a molecular method to determine rates of outcrossing within these native grasses. Field and greenhouse studies were tested to determine whether seedlings that put more energy into growing roots, rather than leaves, were more competitive with cheatgrass. They also determined if seeds collected from cheatgrass invaded areas were better at growing with cheatgrass than seeds from non-invaded areas.

Results

Federal and state agencies are now beginning to recognize the importance of the evolutionary potential found in genetically diverse restoration material.

This research shed light on how native populations of Sandberg Bluegrass (*Poa secunda*) can adaptively respond to novel environmental stimuli, such as invasion from Cheatgrass, via phenotypic plasticity. In turn, this will allow restorationists to identify native plant populations that may become locally adapted to persist in the face of disturbance from Cheatgrass.

Ultimately, the results of this research will better inform restorationists of where to look for such locally adapted genotypes as plants from these locations can serve as a source of seed production and collection and thus the improvement of current restoration practices.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
121	Management of Range Resources
122	Management and Control of Forest and Range Fires
136	Conservation of Biological Diversity

Outcome #5

1. Outcome Measures

Developing a Better Understanding of Nutrient Transport in Sierran Watershed Soils

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In healthy coniferous ecosystems, rapidly decomposing litter can sustain a short-term cycling of nutrients from the canopies to the soils and back to the canopies. However, an accumulating forest floor similar to that now present in the eastern Sierras tends to hold nutrients leading to the buildup of large pools of nitrogen and phosphorus that may instead enhance nutrient discharge to

adjacent surface waters e.g., Lake Tahoe and other Sierran lakes.

An environment where the forest litter builds up on the surface of the soil faster than it degrades is thus undesirable for forest management because nutrient cycles develop progressively slower rates of turnover, and the forest floor is no longer able to maintain a short term nutrient cycle.

The overriding goal of this research is to further develop a quantitative database that will assist in the application of appropriate adaptive management strategies while incorporating the protection and effective management of critical watershed values. This investigation seeks to better characterize the natural nutrient transport processes within the upper watersheds that preferentially infiltrates into Sierran soils prior to final tributary discharge.

What has been done

Direct (soil cores) and passive sampling (resin capsules and lysimeters) methods were used to investigate the seasonal and annual spatiotemporal distribution of nutrient "hot spots" along the Sierran front northward to the base of the Cascades. Vegetation inventories and soils chemical analyses were conducted to obtain baseline data. All sites were outfitted with runoff and snow-melt collectors and data was collected annually for chemical analyses.

Results

The potential transport of nutrients from the terrestrial to the aquatic system can play a major role in the continued deterioration of water quality in the eastern Sierras and Lake Tahoe. If these nutrient laden waters enter the soil before discharge into surface waters, they are likely to create hot spots of very high nutrient concentrations, which in turn have significant implications for forest nutrition and surface and ground water quality.

This project has quantified the presence and spatial distribution of biogeochemical "hot spots" or "hot moments" relative to the surrounding soil matrix, how they are affected by fire, their geographic characteristics, and their potential impact on discharge water quality and Lake Tahoe's clarity. This new knowledge is helping management agencies make better informed decision. The current list of participating agencies include the Tahoe Regional Planning Agency, Lahontan Water Quality Management Board, California-Nevada Conservancy, and in particular the USFS Lake Tahoe Basin Management Unit.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
132	Weather and Climate

Outcome #6

1. Outcome Measures

Sagebrush Demography and Climatic Controls in Nevada's Semi-arid Ecosystems

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Shrub establishment in semi-arid areas is episodic in natural populations. The identification of when recruitment (establishment) pulses naturally occur can assist land managers in ecosystem rehabilitation/reclamation and restoration activities. Knowing the climatic variables responsible for these pulses will improve our ability to ensure success when resources are expended on restoration and wildlife improvement activities. If we understand the climatic conditions responsible, we can manipulate seed beds and microsites or modify cultural practices to improve establishment efficiency.

This study will identify the environmental conditions that have allowed natural sagebrush populations to establish and survive through extended periods of time, so that these conditions can be duplicated where necessary to enhance the establishment and survival of sagebrush.

What has been done

Seedling (cohort) origin years were determined from growth-ring analysis. Over a two years period, Black, Lahontan, Low, and Wyoming Sagebrush samples were collected for inclusion in annual growth-ring analysis. Stem cross sections were prepped, growth rings counted, and statistical analyses were conducted. Correlating to site locations, weather data back to 1925 was collected along with topography (slope, aspect and concavity) and soil texture information. Estimations were also made of current grazing pressures and current vegetation associated with the site.

Results

The most interesting finding of this research was the significance of global climatic patterns. Monthly Pacific Decadal Oscillation (PDO) index variables were correlated with seedling recruitment in all species studied. In general the shift from cool to warm phase of the PDO corresponded with increased sagebrush cohort recruitment. These results suggest that timing

restoration efforts with the larger climatic environment may result in increased success.

This is the first set of data ever published on Black, Lahontan, and Low Sagebrush growth-ring analyses. The recruitment intervals have now been included in state-and-transition models developed by the University of Nevada for BLM's ecological sites across Nevada with the potential to support sagebrush. These additions will provide restoration/rehabilitation practitioners, mined-land reclamation professionals, and ecological site delineation teams with more detailed requirements for sagebrush establishment in the Great Basin, leading to more efficient seeding activities.

The principle investigator and graduate student assigned to the project have learned new statistical techniques that deal more precisely with multitude of variables. In the past, logistic regression statistics were used to elucidate pulse recruitment phenomenon in semi-arid ecosystems. This required polytomous variables to be collapsed into presence (yes) - absence (no) formats. The team has discovered a way to maintain the polytomous nature of the data, while still relating it to the predictor variables.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
121	Management of Range Resources
132	Weather and Climate

Outcome #7

1. Outcome Measures

Hydrologic and Vegetative Response to Pinyon-Juniper Treatments at the Watershed Scale

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Rural Nevada economies are strongly tied to farming and livestock production. The encroachment of pinyon pine and juniper into sagebrush-steppe ecosystems has reduced the forage base for livestock and wildlife species, increased soil erosion thus reducing the soil's ability to produce forage and potentially has had a negative impact on groundwater recharge. In addition, as woodlands mature and fuel loads shift from ground fuels to canopy fuels, fire frequency is reduced but fire intensity increases significantly, altering seed banks and further reducing understory species diversity. Anecdotal evidence has suggested that pinyon-juniper (PJ) encroachment has decreased water yields and that understory vegetation is essentially competing for limited water resources, though this has not been rigorously tested.

In arid Nevada, water is a scarce commodity utilized by wildlife, livestock and farmers for crop production therefore understanding the water use of pinyon - juniper woodlands will improve management's ability to predict both vegetation and groundwater recharge response to tree removal. Additionally, multiple treatment options exist for reducing the impact of pinyon -juniper on Nevada rangelands. Treatment options range from prescribed fire, to harvesting for biomass, to felling and leaving on site. Understanding the impacts of different treatment options on soil stability (erosion) and vegetation response will improve management's ability to determine the appropriate treatment for diverse ecosystems.

What has been done

The team of scientists from UNR determined how much precipitation is intercepted and used by PJ trees at the tree scale. Information developed at the tree scale was then scaled up to the watershed level with the use of GIS technology, providing science-based predictions of water use by PJ trees under different rainfall intensities. Additionally, the project provided information on the amount of soil erosion generated under different rainfall events within PJ dominated sagebrush plant communities. Finally, the project monitored vegetation and groundwater response to PJ treatment (felling) at the watershed scale.

Results

The outcomes of this project were multifaceted; there is now a fundamental understanding of canopy interception of precipitation by PJ trees. This knowledge will have future impacts on restoration efforts to control PJ encroachment. There is also a new understanding of soil erosion on treated (cutting of pinyon and juniper trees) areas. These project results influence overall watershed health and impacts of tree cutting on down-slope and downstream water quality as well as infiltration of water into the soil matrix in treated areas. Infiltration and runoff are directly related to plant available moisture which influences understory plant community response after treatment of trees.

The project also represents an intense field effort, based out of a remote camp in central Nevada. Students, post-docs, and technicians were in the field continuously from late March - September each year of the project. Such experiences provided substantial training in managing a field study, supervising personnel and learning both practical and natural history aspects of field biology.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management

121 Management of Range Resources
132 Weather and Climate

Outcome #8

1. Outcome Measures

Synergistic Monitoring for Adaptive Vegetation Management in the Sagebrush Ecosystem of the Great Basin

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

It is estimated that more than 25,000 land treatment and wildfire events have occurred in Nevada since the early 1900's. Since then, scientists and land managers have been monitoring and conducting experiments on a substantial proportion of these events. A need was expressed for better information about the ecological resiliency and resistance on a regional scale. This project coordinated monitoring efforts and pooled monitoring data across organizations and individuals because the sum is more valuable than the individual components.

What has been done

In partnership with a whole host of collaborators, University of Nevada initiated a State-wide effort to capture, consolidate, and summarize implementation, monitoring, and research information for land treatments events that maintain or improve Nevada's sagebrush ecosystem. To achieve this goal, the team inventoried past land treatment data available from agency offices. They collected and analyzed monitoring data from selected recent, current and planned projects. The team also conducted field studies to identify and fill information gaps. All information was then compiled into a content management system known as SynMon. This database has now been made available to a large contingency of stakeholders including USDA (ARS, Humboldt-Toiyabe NF, and Rocky Mountain Forest and Range Experiment Station), USDI (BLM & FWS), and USGS.

Results

Rangeland management professionals have expressed increased interest in monitoring and in sharing data since becoming aware of this study. A large portion of SynMon's data has now been incorporated into USGS's Land Treatment Digital Library. USDA's Rock Mountain Experiment Station has used SynMon data to design and implement a five year vegetation monitoring

program for habitat restoration in Elko and Eureka counties in Nevada, along with historical data for Bridgeport Ranger District, CA and Douglas county Nevada. The information contained within SynMon has also been used to support and reinforce ecological site descriptions used in BLM's state and transition models throughout the Great Basin districts.

By working in close association with graduate students and various interdisciplinary graduate programs, the UNR faculty have augmented research and educational discussions. The project allowed graduate students the advantage of using select portions of the overall database to conduct a refined project with a narrow focus across an appropriate domain. The project also trained undergraduate students on how to work on field projects and to otherwise assist with project implementation, data input, sample measurement, etc.

4. Associated Knowledge Areas

KA Code	Knowledge Area
103	Management of Saline and Sodic Soils and Salinity
112	Watershed Protection and Management
121	Management of Range Resources
123	Management and Sustainability of Forest Resources
132	Weather and Climate
135	Aquatic and Terrestrial Wildlife
136	Conservation of Biological Diversity

Outcome #9

1. Outcome Measures

Pheromone Control of the Invasive Bark Beetles

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Bark beetles are an aggressive, destructive pest of pine forests in western North America. Historically, unprecedented outbreaks in Alaska and British Columbia are devastating forests

there, and nearly a third of the trees in the Lake Tahoe basin have been killed, partially due to this insect's activity. Because they spend the majority of their life cycle beneath the surface of their host trees, they are difficult to control by conventional methods.

We are trying to develop new control strategies based on the beetle's reliance on pheromones for successful mating. This project investigates the production of these chemicals in beetle tissues, and characterizes the genes involved in their production and/or degradation. Knowledge gained from this work will form the basis upon which future management strategies may well be developed.

What has been done

The team has been busy unraveling a family of enzymes (P450) involved in both the production of mating pheromones and the detoxification of a turpentine precursor terpene produced by pine trees as a natural defense. Thus far, the UNR team has characterized the first known terpene-hydroxylation P450s enzyme in bark beetles. An import step in detoxification. The biggest accomplishment thus far is proof-of-concept at the bench scale for the production of multiple commercially sought after chemicals.

Results

The project has led investigators to believe that a natural product could be produced from the discovery of how P450 enzymes dock to terpenes. The typical methods for mass production of ipsdienol are dangerous. However, you can buy myrcene (a common commercial terpene) for 10¢ a gram, run this through the P450 system and produce a \$380 per gram ipsdienol and when purified could be worth as much as \$1,200 per gram, all the while, under very safe production conditions. Limonene, a precursor to menthol, is a \$500 million per year market and yet another product that could be produced via the P450 systems.

Based on the information gained from our research, and interactions with the UNR's Technology Transfer Office, we leveraged our work into a successful NSF I-CORPS award to learn how to effectively function in a commercial setting. As a result, a new start-up effort, EscaZyme Biochemicals, LLC was launched to further explore commercializing our technologies.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
211	Insects, Mites, and Other Arthropods Affecting Plants
216	Integrated Pest Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Programmatic Challenges
- Other (Budgetary Restraints)

Brief Explanation

Another year of State budget shortfalls continue to narrowed the breadth of NAES's research programs. Fewer research projects will be supported and recruiting graduate students will be difficult.

The Experiment Station is still trying to recover from the 31 hard money positions lost after the 2010 circulation review. The natural resources and environmental science program is also facing the loss of two soil scientist. Their replacement will require a minimum of one year to recruit, hire and establish research programs that contribute to NAES's mission.

The circular review has also produced a number of administrative issues that contribute to the outcomes of our natural resources and environmental science program: the potential merger with Cooperative Extension, all faculty changing from 12 month to 9 month appointments, and the uncertainty regarding administrative changes (Dean/Director).

V(I). Planned Program (Evaluation Studies)

Evaluation Results

- Leveraged over \$3,85 million in extramural funding
- Won Gold in the 2013 Sontag Entrepreneurship Competition and received NSF's Innovation Corps grant
- Trained 85 students in field and lab techniques
- Have assumed the leadership role in America's oldest, continuous mountain lake environmental program

Key Items of Evaluation

A new start-up company, EscaZyme Biochemicals, LLC was launched to further explore commercializing our pheromone production system.