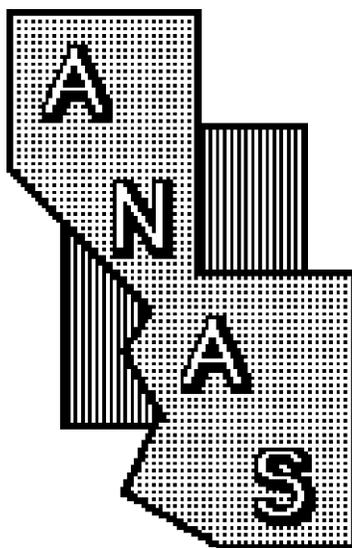


2014

VOLUME 49

**PROCEEDINGS
OF THE
ARIZONA-NEVADA
ACADEMY OF SCIENCE**



FIFTY EIGHTH ANNUAL MEETING

April 12, 2014

**Northern Arizona University
Flagstaff, AZ**

**Proceedings of the
58th Annual Meeting of the
ARIZONA-NEVADA ACADEMY OF SCIENCE
April 12, 2014
Northern Arizona University
Flagstaff, Arizona**

Table of Contents

Abbreviated schedule and activity locations.....	3
Summary of section meetings.....	4
Sponsors.....	5
Luncheon speaker.....	6
Biology/Geology session.....	7
Hydrology session.....	12
Mathematics/ Physics session.....	22
Poster session.....	24
Academy business and annual reports.....	38
Officers 2013-2014.....	38
President’s Report.....	39
Membership Report.....	40
Necrology Report.....	40
Minutes of the Annual Business Meeting and Awards Luncheon.....	41
Outstanding Service Award.....	43
Bud Ellis Scholarship	44
Science Bowl/Science Olympiad Report.....	45
Treasurer’s Report.....	48

ABBREVIATED SCHEDULE AND ACTIVITIES LOCATIONS

Friday, April 11, 2014

Board of Governor's meeting 5:30-8:30 pm, Room 102

Saturday, April 12, 2014

All section meetings on Saturday will take place in the Southwest Forest Science Complex on the campus of Northern Arizona University, Flagstaff, AZ

7:00-8:30	Registration: Lobby
8:00-10:00	Paper Session I: See section schedules
10:00-11:00	Coffee Break and Poster session: Lobby
11:00- 12:00	Paper Sessions continue: See section schedules
12:00-1:30	Awards Luncheon/Annual Business Meeting: Lobby
1:30-3:45	Paper Session II (Hydrology): See section schedule

SUMMARY OF SECTION MEETING

Section	Time	Room
Biology/Geology	9:00	133
Hydrology	I 8:00 II 1:30	136
Mathematics/Physics	8:30	135
Posters Session	10:00	Lobby

All rooms are in School of Forestry Building

SPONSORS

The Arizona-Nevada Academy of Science would like to thank the following Northern Arizona University sponsors for their generous contributions to the fifty-eighth annual meeting of the Academy:



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LUNCHEON SPEAKER

Dr. Paul Keim

"Plague and its Expansion around the Globe"

Dr. Paul Keim is currently a Center Director at Northern Arizona University and a Division Director at The Translational Genomics Research Institute (TGen). He holds the Cowden Endowed Chair in Microbiology and is a Regents' Professor of Biological Sciences at NAU. He is a guest scientist at Los Alamos National Laboratory and a Board Member at PathoGene, LLC. He has scientific expertise in science policy, genetics, microbiology, genomics, infectious diseases and biodefense. He has published over 300 scientific and policy papers and given over 250 invited speeches. In his 25 years at NAU, he has raised over \$60 million in research grants. He is one of the founders of microbial forensics and his work was instrumental to the federal investigation and identification of the anthrax-letter attacks' perpetrator. He continues to serve as a scientific advisor for the FBI.

Dr. Keim is a lumberjack, having graduated from NAU with a Bachelor of Science degree in both Biology and Chemistry in 1977, *magna cum laude*. He received his PhD from the University of Kansas in Botany in 1981 with Honors. He served two postdoctoral fellowships at the University of Utah from 1981-87 in bacterial genetics and microbiology, and at Iowa State University in plant genetics (1987-88). In 1989 he returned to NAU as an Assistant Professor of Biology. He appointed the Raymond and Ruth Cowden Endowed Chair in Microbiology in 1997 and was promoted to Regents' Professor of Biology in 2002. In 2012, the Arizona Bio Industry Association selected him as the Arizona Biomedical Researcher of the year, the same year that NAU honored him as the University Innovator of the Year and Research Mentor of the Year. He co-holds the first patent ever issued to an NAU faculty member with an NAU undergraduate student.

Dr. Keim has served on numerous federal advisory committees on biodefense, genomics and dual use research. He has been a member of the inter-department National Science Advisory Board for Biosecurity (NSABB) since 2005 and served as its Acting Chairman from 2010 to 2012. He has testified before Congress three times, most recently to the Lieberman-Collins committee on Homeland Security concerning avian influenza. In 2012, he was chosen by the Arizona Bio Industry Association as the Biomedical Researcher of the Year.

The University of Kansas selected him as a distinguished alumnus in 2004. Virginia Tech University selected him as the Dr. Charles E. Hamner Lecturer in 2005. He gave McPherson College's Mohler Lecture in 2004. NAU selected him as the Centennial Distinguished Professor in the Sciences in 1998. The NAU chapter of *Phi Kappa Phi* selected him the NAU Faculty Scholar of the Year in both 1995 and 2002.

Numerous professional societies have honored him, including the American Academy of Microbiology which elected him as a fellow in 2002. The American Biosafety Association gave him the Arnold G. Wedum Lecture Award in 2011. The American Agronomy Society gave him the Klepper Honorary lecture award in 2002.

BIOLOGY/GEOLOGY SESSION

SESSION: 9:00

ROOM: 133

CHAIRPERSONS: Robert Bowker and Robert McCord

9:00-9:15 *USE OF ACOUSTICS TO DETER BARK BEETLES FROM ENTERING TREE MATERIAL

Nicholas C. Aflitto and Richard W. Hofstetter (Northern Arizona University, Flagstaff, AZ)

Acoustic technology is a potential tool to protect wood materials and eventually live trees from colonization by bark beetles. Bark beetles such as the southern pine beetle *Dendroctonus frontalis*, western pine beetle *D. brevicomis* and pine engraver *Ips pini* (Coleoptera: Curculionidae) use chemical and acoustic cues to communicate and to locate potential mates and host trees. In this study, the efficacy of sound treatments on *D. frontalis*, *D. brevicomis* and *I. pini* entry into tree material was tested. Acoustic treatments significantly influenced whether beetles entered pine logs in the laboratory. Playback of artificial sounds reduced *D. brevicomis* entry into logs, and playback of stress call sounds reduced *D. frontalis* entry into logs. Sound treatments had no effect on *I. pini* entry into logs. The reduction in bark beetle entry into logs using particular acoustic treatments indicates that sound could be used as a viable management tool.

9:15-9:30 INCREMENTAL GROWTH LINES IN TEETH OF THE GLYPTODONT, GLYPTOTHERIUM TEXANUM (XENARTHRA, CINGULATA) FROM THE PLIO-PLEISTOCENE OF ARIZONA AND MEXICO

David D. Gillette (Museum of Northern Arizona, Flagstaff, AZ)

Oscar Carranza-Castañeda (Universidad Nacional Autonoma de Mexico, Campus Juriquilla, Queretato, Mexico)

The dentition of *Glyptotherium texanum* (Xenarthra, Cingulata) consists of 8 molariform teeth in each jaw. Teeth lacked enamel, but were hypselodont and grew throughout life. Teeth are three-lobed prisms, with a flat occlusal surface that functioned as a grinding mill for vegetation. Each tooth has an inner ridge of osteodentine and anastomosing branches into each lobe, surrounded by softer orthodentine that grades into a resistant rim that forms the external perimeter. Incremental lines on the external surface of the osteodentine rim are trough-and-crest couplets slightly less than one millimeter apart. Teeth of *G. texanum* from Mexico have monotonously regular spacing and

depth, but teeth from the Arizona population show less regularity and uneven depth. In addition, coarser incremental lines with a different character occur in the cementum that occupied the space between the tooth and the alveolus. Both sets of incremental lines appear to be related to continual growth of the teeth. The smaller increments may be diurnal alternations of relative high and low growth rates in the tooth germ related to daily fluctuations of metabolic activity. Each tooth has approximately 100 diurnal couplets, in aggregate representing 100 days of growth. The larger increments are less regular and appear to repeat twice monthly in a circaseptan rhythm. Interpretations of these observations involve speculation on metabolism, diet, and environment.

9:30-9:45 HAS PANDORA'S BOX BEEN OPENED? A STUDY ON THE PANDORA MOTH IN NORTHERN ARIZONA

Barbara Sugarman¹, Andrew Mann¹, Kristen Potter¹, Amanda Grady², Richard Hofstetter¹
(¹Northern Arizona University School of Forestry, ²USDA Forest Service Southwestern Region, Albuquerque, NM)

The pandora moth (*Coloradia pandora*) is a native insect that has a 2-year life cycle and feeds on ponderosa pine needles. Approximately every 20 to 30 years, this insect reaches outbreak levels that last for 6 to 8 years. Tree defoliation by pandora moth caterpillars can decrease tree growth, diminish visual quality, and sometimes result in tree mortality. Little information is known about pandora moth population dynamics, distribution and biology in Arizona. The objectives of this study were to determine the occurrence of the moth on the Kaibab National Forest north and south of Grand Canyon National Park; and quantify caterpillar and moth abundances and defoliation levels. Effectiveness of natural enemies (including diseases) and climatic data were also studied in comparison to pandora moth densities. We found that caterpillar abundances were high during 2013, indicating that adult moth abundances should be high in 2014. Compared to previous years, percentage of affected caterpillars by virus increased, indicating that this pathogen may result in the population declining during the next generation of caterpillars. 2013 surveys, both on the ground and air, indicate that tree defoliation severity has increased greatly, particularly in the ponderosa stands north of Jacob Lake, AZ. Moth populations around the rim of the Grand Canyon do occur but are low relative to densities further north.

9:45-10:00 INCREASED DIVERSITY OF PTERASPIDS (AGNATHA, HETEROSTRACI) IN THE MIDDLE DEVONIAN OF WESTERN NORTH AMERICA

Michael Serio, and David Elliott (Northern Arizona University, Flagstaff, AZ)

The heterostracans are extinct Paleozoic jawless vertebrates that were covered anteriorly by a carapace of bony plates that were easily fossilized. Characteristically the gills open through one opening on each side of this carapace. They lived in non-marine environments around the Old Red Sandstone continent, a continent formed by the joining of North America and Western Europe together with Greenland and Spitsbergen. Pteraspids are a taxon of heterostracans that lived from

the Late Silurian into the Early Devonian periods (418-397 Ma), and are characterized by a specific arrangement of head plates. They are abundant enough to be used extensively for biostratigraphy in Western Europe. The last pteraspids are known from Middle Devonian channel deposits of western North America (Idaho and British Columbia). They constitute the last members of a local radiation in western North America of taxa that have tuberculate ornament on the surface of the bony plates rather than the ridged ornament that is characteristic of pteraspids in general. Material from these localities was described in this project to increase our understanding of this stage in the evolution of the group. Although specimens had been described from the Spring Mountain channel in Idaho in 1968 new material has enabled a more complete description of one species and recognition of an additional new species, while new material from British Columbia has allowed a more complete description of those taxa. This work helps to expand the current base of knowledge about pteraspids in the Middle Devonian and indicates a higher level of diversity at this time than was previously recognized.

10:00-11:00 COFFEE BREAK/POSTER SESSION: LOBBY

11:00-11:15 CONVERGENT EVOLUTION OF HIGH-PERFORMANCE SWIMMING MORPHOLOGY IN AN ARIZONA FRESHWATER FISH

Clinton Moran and Alice Gibb (Northern Arizona University, Flagstaff, AZ)

Waterways in the lower Colorado River basin were historically defined by periodic flooding events as a result of snow-melt and seasonal rains. We examined the vertebral column morphology, red muscle location, and shape of the fins of roundtail chub (*Gila robusta*) and bonytail chub (*Gila elegans*), two species native to the Colorado River Basin, to test the hypothesis that native fish have evolved a morphology that enhances swimming performance. We compared the roundtail chub and bonytail chub to an invasive, low-performance swimmer from the same family, the common carp (*Cyprinus carpio*) and a high-performance swimmer from the marine environment, the chub mackerel (*Scomber japonicus*). Skeletons were cleaned and the vertebral column morphology was made visible by a colony of dermestid beetles. From intact fish, seven sections were cut along the axial body based on a percentage of standard length and the following parameters were measured: red muscle surface area and the ratio of red to white muscle for each section. Fin aspect ratio was measured as fin span squared divided by the surface area of the caudal fin using ImageJ. Native fish were not similar to mackerel in finness ratio or the red to white muscle ratio. However, caudal fin shape and the angle of the neural and hemal spines in the caudal peduncle in the bonytail and mackerel suggest that the bonytail caudal fin is modified to enhance swimming performance. A narrow caudal peduncle with folded over neural and hemal spines likely allows for hydrodynamic advantages during rapid swimming. The narrow caudal peduncle allows for minimal drag which causes the caudal fin to displace most of the water during swimming. This allows the caudal fin to do most of the work during propulsion while limiting drag forces caused by the body.

11:15-11:30 COI SEQUENCING OF TWO UNDESCRIBED LEECH SPECIES FOUND AT MONTEZUMA WELL, ARIZONA

Rebecca Beresic-Perrins), Kelsey Banister, Adam Vazquez, Jamal Wells, Isabel Gonzalez, Theresa Rizza (Northern Arizona University, Flagstaff, AZ), Fredric Govedich (Southern Utah University, Cedar City, UT) and Stephen Shuster (Northern Arizona University, Flagstaff, AZ)

Montezuma Well is a collapsed limestone well in Montezuma Castle National Park in the Verde Valley of Central Arizona. This habitat has been separated from other major aquatic systems for over 11,000 years, and contains the high levels of CO₂ and arsenic in its waters, conditions which exclude aquatic vertebrates and have allowed invertebrates to occupy higher trophic levels. Two common freshwater leeches, presently described as *Helobdella stagnalis* and *Helobdella triserialis*, are two of four leech species known to inhabit Montezuma Well. We hypothesize that these two *Helobdella* species are undescribed and endemic to Montezuma Well. We extracted DNA and sequenced the cytochrome c oxidase subunit I (COI) region of the mitochondria in five individuals of both species collected from Montezuma Well. Using GenBank, we cross-referenced our results with those of two other Arizona *H. stagnalis* and *H. triserialis* populations inhabiting White Horse Lake, JD Dam Lake, Rio de Flag, and Oak Creek as well as other closely related leech species. We constructed a consensus phylogeny using MEGA 5.1. Our results indicate that the two leech species from Montezuma Well are in fact two undescribed endemic species. A morphological comparison of these new species with known *H. stagnalis* and *H. triserialis* populations is currently underway.

11:30-11:45 LIFE IN A HALF SHELL: DERMAL ARMOR IN GLYPTODONTIDAE AND DERMOCHELYIDAE

Robert D. McCord (Arizona Museum of Natural History, Mesa, AZ)

“Glyptodonts are like turtles” is one of those obvious truisms that become equally obviously false on examination. Glyptodonts are, however a great deal like Leatherback Turtles (Dermochelyidae). This presentation examines the similarities and dissimilarities of the carapace of Dermochelyidae and that of the Cingulata, particularly Glyptodontidae. The shell of the modern *Dermochelys* was important in early thought on the phylogeny of turtles. The reduced condition of the carapace, with little modified ribs, a nuchal, and a covering of polygonal osteoderms, was thought to represent the primitive condition in turtles. This notion still colors thought on the origin of the carapace. The osteoderms, in chelonian literature, are termed epithelial bones with the underlying shell (if present) termed thecal. The nature of the thecal bones is of long running controversy. Osteoderms are an evolutionary novelty in advanced **Dermochelyidae** with the earliest forms (such as *Mesodermochelys*) having no epithelial bones, a relatively complete thecal skeleton and epidermal scutes. No other turtle, including the basal *Odontochelys*, possesses osteoderms, except *Proganochelys*. Osteoderms in Xenarthra are distributed in the mylodont sloths and the Cingulata. In the mylodonts they are isolated, presumably the primitive condition. In the Cingulata we have sub-hexagonal, sutured osteoderms in the buckler of armadillos and

pamphateres and throughout the carapace of glyptodonts. In addition, armadillos and pamphateres possess imbricating osteoderms, the condition in the common ancestor of the Cingulata is unclear. From this divergent origin, the osteoderms of the glyptodonts and dermochelyids have converged on a remarkably similar appearance. Both have exterior surface morphology of taxonomic importance, often confounded by variation due to location on the carapace, ontogeny, and gender (a problem shared by the thecal shell of other turtles). Both are hexagonal to sub-hexagonal and articulate by sutures. Both often display on the exterior surface a central figure, surrounded by smaller accessory or peripheral figures. Histologically both taxa's osteoderms consist of exterior and internal layers of compact bone, with a cancellous diploë in the center. Both osteoderms feature prominent Sharpey's fibers and both are highly fibrous and interpreted as metaplastic ossification. Not unexpectedly, there are dissimilarities as well. Dermochelyids, naturally, lacks hair follicles or evidence of sweat glands. Some osteoderms of **dermochelyids** develop a strong keel. In *Dermochelys* the diploë is lost ontogenetically. **Dermochelyids** have an apparently unique position of the growth center as central and near the exterior of the Osteoderm, resulting in the external cortical bone being thinnest at the osteoderm's center. With incredibly different origins and even largely different functions a remarkably similar carapace design has arisen twice. Apparently good engineering is good engineering, in a biologically attainable matter.

11:45-12:00 VIGILANCE IN THE UTAH PRAIRIE DOG (*CYNOMYS PARVIDENS*)

Theodore G. Manno (Catalina Foothills School District, Tucson, AZ)

Vigilance in animals may serve to detect predators or monitor conspecifics. Distinguishing between these hypotheses requires detailed information on vigilant postures during different portions of the reproductive cycle. During a one-year study, I examined the vigilance of over 100 Utah prairie dogs (*Cynomys parvidens*) of mostly known age and genealogy. Male and female prairie dogs exhibited "selfish herd" effects by decreasing vigilance in the presence of more surrounding conspecifics, *i.e.*, when predation risk was low. Reproductive males and females were more vigilant than their nonreproductive counterparts during breeding, and estrous females increased vigilance in the presence of prospective mates. Lactating females were less vigilant than females without litters when neonates were in a nursery burrow and vulnerable to infanticide by males. Males were more vigilant than females, but not when the offspring of their sexual partners were vulnerable to infanticide or opportunities to kill offspring increased. Taken together, these results indicate that vigilance in Utah prairie dogs varies mostly in relation to the risk of predation, although mate competition can increase vigilance for conspecifics.

12:00-1:30 AWARDS LUNCHEON/ANNUAL BUSINESS MEETING: LOBBY

HYDROLOGY SESSION

SESSION 8:00

ROOM: 136

CHAIRPERSON: Daniel Neary

SESSION I

8:00-8:15 USE OF CUMULATIVE EFFECTS ASSESSMENTS IN DETERMINING THE IMPACTS OF HERBICIDE APPLICATION PROGRAMS ON WATER QUALITY

Daniel G. Neary (USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ)

The definition of cumulative effects arose from water quality conferences and workshops in the late 1970s and early 1980s and discussions on the intent of the United States National Environmental Policy Act of 1969 (Code of Federal Regulations 1971). In CFR 1508.7, cumulative effects or impacts are defined as: “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.” Of the cumulative effects types, space and time crowding are the most common effects on water quality associated with herbicides. Synergistic effects are rare and difficult to quantify. Two herbicides in the same tank mix can affect different target weeds but their effects on water quality are usually not multiplicative. Indirect effects on water quality do occur and they can be both negative and positive. Nibbling definitely occurs along stream courses and is caused by a number of nonpoint source pollutants, not just herbicides. Time lag enters into herbicide cumulative effects analyses when residues enter groundwater and their appearance in streams or lakes is substantially delayed. Cross boundary effects can occur with aerial applications and often can be the major source of inputs to water despite buffers and computer control of applications. Trigger and threshold effects are not important considerations in herbicide cumulative effects analyses. Lastly, fragmentation effects do not enter into herbicide cumulative effects analyses.

8:15-8:30 TRACE METAL AND PHOSPHATE PARTITIONING BETWEEN STORMWATER RUNOFF, GROUNDWATER, AND SEDIMENTS ADJACENT TO LAKE HAVASU, ARIZONA

Doyle C. Wilson (City of Lake Havasu City, Lake Havasu City, AZ)

A baseline study to characterize heavy metal and nutrient levels in storm water runoff from Lake Havasu City, Arizona, has also lead to investigating the fate of those constituents in lake water, shallow groundwater and surficial sediments at the mouths of six washes draining from the city into Lake Havasu. Metal and total phosphate concentrations are slightly higher in shallow groundwater than runoff, but order of magnitude increases are apparent for most metals and phosphate from all water sample types to wash mouth sediment samples. Other metals such as cadmium, molybdenum and selenium while sporadically detected in runoff and groundwater were never detected in the sediments. Composite core and pit sediment samples collected at wash mouths before and during historic low lake water levels, reveal a fairly consistent metal and total phosphate presence at most wash sites. Two sites where clay is a more significant component in the sediment have generally higher concentrations. Several trace metal associations in the sediment such as Co-Ni, Fe-Cr and Cu-Zn show a strong correlation among all sediment samples. Metal concentrations at all sites do not indicate a significant variance towards or parallel to the lakeshore, whereas total phosphate concentrations tend to increase in sediments normally submerged by lake water. Reducing conditions prevail within 30 mm of the sediment surface at all locations, yet metal concentrations within 0.6 m of the surface display a spatial change from increasing with depth at northern wash sites to a more variable pattern at southern sites. Phosphate concentration with depth is more variable and may contradict the local metal trends. Metal ion and complex adsorption to mineral and organic surfaces is expected though total organic carbon levels, reflected by the presence of freshly buried vegetation, are highly variable. Black color of sediment cores converts to yellow-brown overnight indicating chemical changes and the subordinate effect of organic matter in the sediment. Wash mouth and shallow lake bottom sediments appear to be a prominent repository for most metals and for total phosphate, though more work is needed to determine the mechanisms involved associating storm water runoff with chemical and sediment deposition.

8:30-8:45 AN INVESTIGATION OF THE EFFECTS OF WETTING/DRYING CYCLES ON PHYSICAL PROPERTIES OF PUDDLED SOIL

Lalu Arifin and Aria Bakti (Northern Arizona University, Flagstaff, AZ)

The structural regeneration of puddled soil as induced by wetting/drying cycles was studied. Two soils were used in this experiment: grey clay (GC_G) and sandy loam (LO_G). The laboratory puddling apparatus used steel rods as puddling implement, attached to a disk driven by a variable speed DC-motor. The input of energy applied in each puddling treatment ranging from 0 to 200 Joules was calculated using the torque and current relationship. Puddling of soil caused disaggregation and dispersion of soil materials. Results showed that the amount of dispersed clay or silt+clay increased with increasing puddling energy. The disaggregation induced by puddling caused a large reduction in Ksat. Regeneration of puddled soil was possible by wetting/drying cycles. In sandy soil (LO_G) puddled with greater energy (150 and 200 Joule) there was a reduction of dispersed clay after the second wetting/drying cycle. Whereas in the finer textured soil (GC_G), a significant reduction in a dispersed silt+clay and clay was evident after each wetting/drying cycles. For sandy soil (LO_G) one wetting/drying cycle to air dry water content improved the soil Ksat. Further improvement in Ksat was evident until fifth cycle. However, in

fine textured soil (GC_G) the recovery of Ksat was not significant except for the soil puddled with energies less than 100 Joules. Therefore, the hostile effect of puddling in fine textured soil should be avoided by puddling soil to the essentially required minimum.

**8:45-9:00 HYDROLOGICAL MODELING EFFORTS OF CHEVELON CANYON,
ARIZONA**

Ian Dai and Aregai Teclé (School of Forestry, Northern Arizona University, Flagstaff, AZ)

This paper is concerned with an on-going hydro-climate study in the Chevelon Canyon, a tributary of the Little Colorado River, in north eastern Arizona. The study involves the first part of building a continuous hydrological model for Chevelon Canyon. This consists first collecting the needed climatological, hydrological, and biophysical data, then analyzing the latter using the U.S. Corps of Engineers Hydrological engineering Center Hydrological Modeling System (HEC-HMS). The work specifically uses the Soil Moisture Accounting (SMA) routine of the HEC-HMS. Preliminary analysis of the modeling process provides adequate information to demonstrate the pros and cons of using the model while shedding some light into the applicability of the model in the study area.

**9:00-9:15 A META-ANAYLYS OF HYDROLOGIC PROCESSES AFFECTED BY
THE SCHULTZ FIRE**

Howard Hoyt and Aregai Teclé (Northern Arizona University, Flagstaff, AZ)

The San Francisco Volcanic Field contains Humphreys Peak, Arizona's highest point, as well as the State's youngest volcano, Sunset Crater, which last erupted around 1,000 years ago. The Schultz Fire occurred on the eastern slopes of the San Francisco Peaks, now part of the Flagstaff Ranger District on the Coconino National Forest. Before the fire, the burned area consisted of overstocked ponderosa pine and mixed conifer. The location had been identified by the US Forest Service as requiring treatment; however, due to litigation involving endangered species the project had not been completed. The fire made its largest run on the first day following anthropogenic ignition. The wind-driven event was then contained on the 30th of June 2010; by that time an emergency assessment for damage control purposes was already underway. The heavy fuel loading coupled with steep topography resulted in high burn severity across the rugged upper reaches. Greater than 40% slopes accounted for 35% of the total burned area and were completely incinerated (Higginson, 2010). A steep, unstable, and hydrophobic landscape was left behind. The fire was unique in that it occurred on the steep slopes upstream from residential and commercial infrastructure. The wild land urban interface situation where debris-flows and flood from the wild land directly affected the urban interface resulted in traumatic events. Higher than normal flood flows are expected from the burn for around five years or until the watersheds recover some of their ability to receive and store water (Neary, 2010). Now roughly four years later, this analysis examines the fire impacts on local hydrologic regimes and the degree to which the burned area emergency response (BAER) was successful. The effects on the ecosystem and downstream wild land urban interface are considered.

**9:15-9:30 EFFECTS OF CLIMATE CHANGE ON LAND USE AND LAND COVER
ON THE SAN PEDRO RIVER, ARIZONA**

Jason Klotz (School of Forestry, Northern Arizona University, Flagstaff, AZ)

There have been changes in land cover and land use in the Southwest with the recent changes in climate there. The Upper San Pedro River Watershed in Southeastern Arizona is no different. The San Pedro River is one of the last perennial rivers in the region. It forms a critical riparian corridor that supports diverse flora and fauna in the area. However, there are drastic changes in the area's water table due to increased water pumping to satisfy the needs of rapid urban growth and other developments. The situation is exacerbated by the continuous drought period in the area. These conditions are altering the vegetation cover in a way that negatively affects the wildlife habitat. Also with the changes in plant cover, there is introduction of exotic species of woody shrubs and trees. Such changes may alter nutrient cycling and water availability to affect the health of other species that have not been directly impacted. As new non-native species move in, the watershed may experience accelerating water and wind erosion activities that result in soil loss, and decrease in water infiltration and storage capacities. This paper is an attempt to address these hydrologic issues, and determine the appropriate level various management actions may be needed.

**9:30-9:45 RESTORATION BENEFITS TO NATURAL SPRINGS IN THE LAKE
MARY WATERSHED**

Clairisse Nash, Aregai Teclé, and Ashley Craig (Northern Arizona University, Flagstaff, AZ)

Hoxworth Springs is one of several natural spring systems located within the Lake Mary Watershed, which the City of Flagstaff uses for part of its municipal water supply. Restoration and conservation of the springs in this watershed are vital to ensuring the city's future drinking water supply and the area's overall ecosystem health. Over 100 years of fire suppression, increased grazing and not well-planned general use have subjected the fragile streams in the Lake Mary Watershed to increased risk of stream bank erosion and general ecosystem degradation. There were some efforts at restoring Hoxworth Springs in the late 1990s and early 2000s that included re-channelization of the stream and the addition of enclosures to reduce elk grazing impacts. The purpose of this study is to examine the current state of Hoxworth Springs and to assess the effects of restoration efforts made on surface soil aggregate stability and vegetation cover. We find that sedge grass cover and surface soil aggregate stability are significantly higher in the restored areas than in the non-restored areas of the springs.

9:45-10:00 IMPACTS OF URBANIZATION ON HYDROLOGIC PROCESSES

Peter F. Ffolliott (University of Arizona, Tucson, AZ, retired)

Urban developments that started when people who came to the United States to build cities, towns, and villages after World War II and have been growing at a record pace ever since. It is not surprising, therefore, that the impacts of this increasing urbanization on hydrologic processes have paralleled the urban developments throughout the country. Many of these impacts have undesirable effects on the water supplies of the urban inhabitants. These effects can often be mitigated through careful planning and implementation of proposed urban developments coupled

with adequate knowledge of the hydrologic processes confronted. These topics are the focus of this paper.

10:00-10:15 BUSINESS MEETING

10:15-11:00 COFFEE BREAK/POSTER SESSION: LOBBY

11:00-11:30 QC CHALLENGES OF COLLECTING TIME-CONTINUOUS WATER QUALITY DATA

Michael Tomlinson and Eric De Carlo (University of Hawaii at Mānoa, Flagstaff, AZ, and Honolulu, HI)

Two MAPCO₂ water quality buoys (WQBs) have been deployed for 5 years a few hundred meters offshore of Waikīkī and downtown Honolulu (O‘ahu, Hawai‘i). These WQBs are jointly operated by NOAA/PMEL (Pacific Marine Environmental Laboratory) and the University of Hawai‘i at Mānoa as part of two programs: the Ocean Acidification Program (OAP) and the Pacific Islands Ocean Observing System (PacIOOS). The PMEL-designed MAPCO₂ buoys collect CO₂ data from surface seawater and marine boundary air every 3 hours; PacIOOS installed additional water quality sensors on these buoys to measure temperature, salinity, dissolved oxygen (DO), turbidity, and chlorophyll *in situ* in the top meter of water every 20 minutes. Quality control (QC) of data from these sensors presents some unique challenges in these shallow, subtropical waters; this is particularly true of the DO and turbidity/chlorophyll sensors as a result of biofouling and calibration drift. We found it essential to check data at different time scales in order to QC the data. These checks range from twice-daily to evaluations that may span years. Aquarius® software, specifically designed for time-series data, is instrumental in QC of the data. Using this software and so-called surrogate data plus information on instrument servicing and sensor calibration, the vast quantities of data (currently well over 125,000 lines each) are examined, evaluated, flagged, and adjusted, as necessary.

11:30-12:00 EFFECTS OF PRESCRIBED FIRE AND A WILDFIRE ON OAK SAVANNAS IN THE PELONCILLO MOUNTAINS OF THE SOUTHWESTERN BORDERLANDS REGION

Gerald J. Gottfried (U.S. Forest Service, Rocky Mountain Research Station, Phoenix, AZ), Peter F. Ffolliott (University of Arizona, Tucson, AZ, retired), Daniel G. Neary (U.S. Forest Service, Rocky Mountain Research Station, Flagstaff, AZ) and Donald D. Decker (USDA Natural Resources Conservation Service, Douglas, AZ)

Fires were a major disturbance in the oak savannas and woodlands prior to European settlement in the late 19th Century. Subsequently, fires became less common because of overgrazing by livestock and aggressive fire suppression by land management agencies. The result was an increase in woody species, a decline in herbaceous cover and in ecological diversity. Private and public land managers are attempting to reintroduce fire to improve the productivity and biological diversity of these landscapes. The Cascabel Watershed Study was established in the Peloncillo Mountains of Arizona and New Mexico at the request of managers to determine the effects of cool-season and warm-season prescribed fires on the hydrology and sedimentation dynamics of a typical Madrean oak savanna. A wildfire added to the treatment mix. The study site contains 12 instrumented small watersheds ranging in size from 20 to 60 acres each with two Parshall flumes. One flume measures typical low flows and the other measures the unusual large storm flows. The area also has two weather stations, and seven supplemental recording precipitation gages. Every watershed contains a sampling grid to measure vegetation, wildlife, and erosion and a series of channel cross sections. All fire treatments resulted in low fire severities. The effects of the different fire treatments on overstory trees, herbaceous production, ground cover, and selected wildlife species and channel stability have been presented in a variety of technical outlets. Results did not show many significant differences among treatment or with pre-treatment conditions. The large foundation of physical and biological information that exists for Cascabel provides a basis for evaluating future impacts of climate change in this region.

12:00-1:30 AWARDS LUNCHEON/ANNUAL BUSINESS MEETING: LOBBY

SESSION II: 1:30

**1:30-1:45 ARIZONA WATERSHED SYMPOSIA: A FORUM FOR REPORTING
EARLY WATERSHED MANAGEMENT ACTIVITIES**

Peter F. Ffolliott (University of Arizona, Tucson, AZ; retired)

The Arizona Watershed Symposia, later simplified to the Arizona Water Symposia, served as a forum for presenting relevant research results, the status of operational management practices, and policy issues relating to what was called the Arizona Watershed Program. This program was a collaborative initiative of the Arizona State Land Department, U.S. Forest Service, and federal, state, and private collaborators to obtain and extrapolate research findings for watershed management interventions that might increase stream flow volumes and other watershed-based values through manipulations of vegetative cover. The proceedings of these symposia, which started in 1957 and continued more-or-less uninterrupted into the early 1990s, represent an indispensable account of the early research and management activities on the state's watersheds and, in doing so, provide a permanent record of these activities.

1:45-2:00 WATER HARVESTING IN ARID AND SEMI-ARID REGIONS

Peter F. Ffolliott (University of Arizona, Tucson, AZ, retired) and Daniel G. Neary (U.S. Forest Service, Flagstaff, AZ)

Water harvesting, also called rainwater harvesting, is an ancient technique of capturing water to augment the quantity and quality of existing water supplies or providing water where other sources are not available or too costly. Water harvesting systems include methods for collecting and storing rainfall and the resulting overland flows of water until it can be used for livestock, agricultural production, or domestic use. The systems require a catchment area to facilitate the collection of water and a storage facility for the harvested water unless the water is to be concentrated in the soil profile for growing plants. A distribution scheme is also needed in systems furnishing water for irrigation. Water harvesting techniques can be applied in almost any region with at least 100 mm of annual rainfall.

2:00-2:15 CONTRIBUTIONS OF SILVICULTURE TO WATERSHED EXPERIMENTS IN ARIZONA'S PONDEROSA PINE FORESTS: A HISTORICAL REVIEW

Gerald J. Gottfried (U.S. Forest Service, Phoenix, AZ), Peter F. Ffolliott (University of Arizona, Tucson, AZ, retired), and Daniel G. Neary (U.S. Forest Service, Flagstaff, AZ)

Silvicultural studies on the Fort Valley Experimental Forest, the oldest experimental forest in the United States, have been a basis for planning and implementing watershed management experiments in southwestern ponderosa pine forests. The primary purpose of these experiments was to evaluate silvicultural prescriptions for increasing stream flow volumes while sustaining or improving other resource values. Knowledge gained from these experiments has provided today's managers with a better appreciation of past management of Arizona's ponderosa pine forests. The effects of implementing selected silvicultural prescriptions formulated largely from studies at Fort Valley on stream flow volumes and other watershed values are reviewed in a historical context in this paper.

2:15-2:30 FOUR FOREST RESTORATION INITIATIVE: APPLICATIONS OF SILVICULTURE FOR THE MANAGEMENT OF ARIZONA PONDEROSA PINE FORESTS

Gerald J. Gottfried (Rocky Mountain Research Station, U.S. Forest Service, Phoenix, AZ), Peter F. Ffolliott (School of Natural Resources and the Environment, University of Arizona, Tucson AZ) and Daniel G. Neary (Rocky Mountain Research Station, U.S. Forest Service, Flagstaff, AZ)

The application of silviculture must be adaptive to be effective. Silvicultural studies conducted at the Fort Valley Experimental Forest in northern Arizona continue to be a basis for collaborative planning for the management and restoration of southwestern ponderosa pine forests. Research results from Fort Valley provide a foundation for the Four Forest Restoration Initiative, a collaborative effort to restore the structure, pattern, and composition of ponderosa pine forests on 2.4 million acres in northern Arizona. Many of the stands in the forests are overgrown with thickets of small-diameter unhealthy trees that can fuel severe high-intensity wildfires. The primary goal

of the initiative is to improve forest health by reducing forest stand densities and loadings of flammable fuels while creating a landscape to support the reestablishment of historic fire regimes. Many of the silvicultural prescriptions in this initiative are based on research findings obtained on earlier Fort Valley studies.

2:30-2:45 THE FOUR FOREST RESTORATION INITIATIVE PAIRED WATERSHED STUDY – UNDERSTANDING FOREST RESTORATION EFFECTS ON WATER BALANCE

Sharon Masek-Lopez (Northern Arizona University, Flagstaff, AZ)

Not since the close of the Beaver Creek Experimental Watershed in the early 1980s has there been a long-term paired watershed study in the forests of Northern Arizona. While past research focused on surface water yield changes in response to forest vegetation management (strip cuts, patch cuts, shelter wood, etc.), no studies have been attempted to evaluate the full water balance in response to forest restoration treatments (uneven-aged management, stand improvement, intermediate thinning, etc.), including follow-up burn treatments that mimic the natural fire return interval. Over a 28-year period the 4FRI paired watershed study will measure precipitation, soil water storage, evapotranspiration, groundwater recharge and surface water discharge across 12 watersheds to evaluate the water balance effects of low, medium and high intensity forest restoration treatments. Methods and instruments will include weather stations, rain gauges, snow surveys, snow pillows, soil moisture sensors, COSMOS neutron probes, eddy covariance towers, chloride mass balance, flumes, sediment traps, in situ turbidity sensors, water auto sampler and laboratory analysis of water quality. Through modeling of ET and water balance, we expect to find that higher intensity treatments (>30 % decrease in basal area; treated forest >40% open) will be most beneficial for improving soil water storage that can help ensure plant vigor and resilience to stressors such as insects, pathogen and climate change. Findings will inform adaptive management to promote healthier, more resilient forests that help assure long-term water supply for Arizonans.

2:45-3:00 POST-FIRE PEAK FLOW DETERMINATION IN SOUTHERN NEVADA

Megan Poff (U.S. Geological Survey, Henderson, NV)

The Carpenter 1 fire began on July 1, 2013 in the Spring Mountains just outside of Las Vegas, NV. It consumed nearly 28,000 acres, mostly composed of steep mountain slopes over 5,000 ft in elevation. Several floods occurred after monsoon rains soaked the denuded land and caused overland flow. To help management agencies assess damages and to support the post-fire runoff modeling that was performed by the U.S. Forest Service, several indirect measurements of flood discharges were surveyed and computed. The following locations and types of computations were chosen for indirect measurements: Harris Springs Canyon, three-section slope-area computation; Lovell Wash, Type I culvert computation; and Stump Spring, step-backwater analysis for developing a stage/discharge relationship coupled with a five-section slope-area computation. Trout Canyon was also considered for peak flow determination, but reconnaissance indicated that the peak flow was actually a debris flow and therefore, standard hydraulic procedures could not be employed to compute flood discharges. The Harris Springs Canyon indirect measurement

showed that the Harris Springs Canyon model developed by the U.S. Forest Service was accurate; the model predicted 3,710 cfs for this rain event and the USGS estimated 3,350 cfs, which is within 10% of the simulated discharge. This is an important step towards validating the U.S. Forest Service models for other watersheds.

3:00-3:15 HYDROLOGY IN THE ABSENCE OF WATER: THE UPPER LAS VEGAS WASH

Boris Poff (Bureau of Land Management, Southern Nevada District, Las Vegas, NV)

The Upper Las Vegas Wash (ULVW) is located just to the North of the Cities of Las Vegas and North Las Vegas and serves as a natural flood control feature between the cities and Sheep and Las Vegas Mountain ranges. Currently under management by the Bureau of Land Management (BLM), there have been many varying demands by public, military and private interests on how to manage the ULVW, ranging from Congressional bills to transfer the ULVW to the National Park Service to demands to make the land available for development. Hydrology and the interpretation thereof has become a pivotal tool in making management decision about the future of this dry desert wash. The BLM has been congressionally mandated to transfer parts of the ULVW out of BLM ownership. Citing the naturally functioning hydrologic condition of ULVW as a principal ecosystem service of the ULVW, BLM has prevented development of the wash so far.

3:15-3:30 LONG-AND SHORT-TERM WATER QUALITY IMPACTS OF FOREST FIRES

Aregai Teclé (Northern Arizona University, Flagstaff, AZ and Daniel G. Neary, Rocky Mountain Research Station, Flagstaff, AZ)

Apart from the destructive effects of a forest fire on the ecosystem and socio-economic conditions of an area, its effect on water quality degradation is also of paramount importance especially in the water thirsty areas of southwestern United States. In many occasions, forest fires have very serious and immediate water quality consequences by introducing hazardous chemicals into water bodies such streams and reservoirs. The authors have examined data from two of the biggest forest fires in Arizona, the Rodeo-Chediski and Wallow fires, to demonstrate the seriousness of the issue in Arizona and many other forest fire-frequented areas in the country. The results may encourage local, state and federal government agencies and other decision-makers to develop better and more proactive policies, guidelines and funding mechanisms to drastically reduce catastrophic forest fires that impact water supplies.

3:30-3:45 BEST MANAGEMENT PRACTICES FOR PROTECTING WATER QUALITY IN BIOENERGY FEEDSTOCK PRODUCTION

Daniel G. Neary (USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ)

The increase in the use of woody biomass, agricultural crops, and agricultural production and processing residues as feedstock for bioenergy production has raised questions about potential impacts on water quality. Best Management Practices (BMPs) have been developed and

implemented since the early 1970s to ensure that land management for wood fiber and agricultural crop production can be conducted with minimum impact on the environment, particularly water quality. The use of BMPs is widespread in developed countries and it varies from mandatory to voluntary. For example, in many countries, BMPs are already incorporated in “Codes of Forest Practice” that guide forest managers through the complete bioenergy life cycle. The development and application of BMPs is not a static process, but one that relies on a continual cycle of application, assessment and monitoring, and refinement. Use of BMPs requires on-going assessment, monitoring, and refinement to craft these practices to best suit local conditions. Best Management Practices ensure that forest and agricultural bioenergy programs can be a sustainable part of land management and renewable energy production.

MATHEMATICS AND PHYSICS SESSION

SESSION: 8:30

ROOM: 135

CHAIRPERSON: Shafiu Jibrin

8:30-8:50 STEADY-STATE ANALYSIS OF A SYSTEM OF ORDINARY

Kevin Coulter (Northern Arizona University, Flagstaff, AZ)

I derived an ordinary differential equation population model for rats. I consider a rat population divided into two age categories, babies and adults. The model allows for the birth, death, and growth of rats from one age category to another. The rats have a non-constant food supply that varies depending on the size of the rat population. I used non-dimensionalization to reduce the number of parameters. Steady-state analysis is applied to the model. A steady-state solution is shown to exist. The linear stability of this steady state is examined using the eigenvalues of the Jacobian and by using the Routh-Hurwitz criteria. Linear stability is shown in both cases. In the Routh-Hurwitz case, stability is shown for a region containing our choice of parameters. The steady-state population as a function of birth rate alone is also considered.

8:50-9:10 *REAL-TIME SURFACE PROFILING OF INDUSTRIAL MATERIALS USING DIGITAL HOLOGRAPHY

Khalid Abdullah Wabli and Tess Mackin (Northern Arizona University, Flagstaff, AZ)

The purpose of this project is to investigate in-situ properties of industrial materials. Multiple wavelength digital holography will be used to observe real-time compression and expansion of a magnetic shape memory alloy (MSMA), specifically Ni₂MnGa, allowing for measurement and characterization of properties such as elasticity, microstructure evolution, and phase transformation. Multiple wavelength digital holography uses a synthetic wavelength created by the interference to two light sources with different wavelengths to achieve resolution on the scale of one to two nanometers. This imaging technique extracts phase shift information from a single image such that the relative heights of surface features are determined, permitting three dimensional reconstruction. This implies the ability to observe time dependent processes in three dimensions. Real-time non-invasive observations could reveal the formation of cracks and/or other weaknesses of material surfaces, providing insight to the limitations and potential applications of MSMA and other materials.

9:10-9:30 *VISUALIZING DIAGRAM FACTORIZATIONS IN TEMPERLEY—LIEB ALGEBRAS

Sarah Salmon (Northern Arizona University, Flagstaff, AZ)

The Temperley—Lieb Algebra of type A, invented by Temperley and Lieb in 1971, is a finite dimensional associative algebra that arose in the context of statistical mechanics. Later in 1971, R. Penrose showed that this algebra can be realized in terms of certain diagrams. Then in 1987, V. Jones showed that this algebra occurs naturally as a quotient of an algebra whose underlying structure is the symmetric group. Similarly, there is also a diagrammatic representation for the Temperley—Lieb algebra of type B involving decorated diagrams. Multiplying diagrams is easy to do. However, taking a given diagram and finding the corresponding reduced factorization is generally difficult. We have an efficient (and colorful) algorithm for obtaining a reduced factorization for Temperley-Lieb diagrams of types A and B.

9:30-9:50 DIFFERENTIAL EQUATIONS AND NEWTON'S METHOD

Travis Wilk (Northern Arizona University, Flagstaff, AZ)

We will present an overview of the basic methods of solving simple first and second order ordinary differential equations. As an example, we will present a solver for the general first order initial-value problem $y' + py = g$, $y(a) = c$, t in (a, b) . We will move into discussing solving more complicated problems that require an approximation method such as Newton's method. We will conclude with showing applications to non-linear 1st and 2nd order ODE problems.

10:00-11:00 COFFEE BREAK/POSTER SESSION: LOBBY

12:00-1:30 AWARDS LUNCHEON/ANNUAL BUSINESS MEETING: LOBBY

POSTER SESSION

SESSION 10:00-11:00

ROOM: Lobby

CHAIRPERSON: Pamela A. Marshall

***MICROBIAL RESPONSES TO THAWING PERMAFROST: WILL THEY ACCELERATE CLIMATE CHANGE?**

Darya Anderson*¹, Maya Sederholm*¹, Eun-Hae Kim¹, Robert Jones¹, Suzanne Hodgkins², Jeff Chanton² and Virginia Rich¹ (*These authors contributed equally to this work;¹ University of Arizona, Tucson AZ; ² Florida State University, Tallahassee, FL)

Permafrost-associated soils cover nearly a quarter of terrestrial land surface, contain more than a third of the world's soil carbon, and are beginning to thaw due to climate change. The microbial response to permafrost thaw may be to release carbon dioxide (an abundant greenhouse gas) and methane (a potent greenhouse gas) into the atmosphere as by-products of their metabolic pathways and thus accelerate climate change. We examined the composition of microbial communities through the soil column at the first stage of thaw (collapsed permafrost) from a sampling site in northern Sweden. Specifically, we used high-throughput sequencing of amplicons of the 16S rRNA gene to profile the communities for overall diversity and specific composition. There were strong depth- and thaw-related changes in relative abundance of the 13 most abundant phyla (all bacterial). We found that the surface layers overlying intact and collapsed permafrost house relatively similar communities, but the communities diverge with depth. The shallow and deep communities do not converge, as might be expected, with thaw but remain distinct in community composition. Thawing appears to be associated with dramatic shifts in conditions like soil pH and carbon:nitrogen ratios, which are likely driving the changing microbiology. Noteworthy specific microbial changes include the large increase with depth (~60 to 90cm) of *Caldiserica* in intact permafrost, up to 65% of the community sequences. We also noticed the appreciable presence of *Cyanobacteria* (a generally phototrophic group) at mid- (~20 to 50 cm) and deeper depths (~90 cm). In addition, since the shift from intact to collapsed permafrost is associated with minor methane emissions, we examined *Euryarchaeota*, the phylum that includes all known methanogens. This phylum comprises ~1.8% of the community sequences of both habitats and is dominated by *Methanomicrobia RCII* and *Methanobacteriales*, both orders of hydrogenotrophic methanogens. Investigations of community structure and analyses of correlations to geochemistry are ongoing and will provide insight into the carbon cycling and possible climate feedbacks from the changing permafrost environment.

***ANALYTICS FOR MEASURING AIRLINE PERFORMANCE: A MIXED METHODS APPROACH**

Blair Boies¹, Brent D. Bowen¹, Erin E. Bowen¹, Dean Headley² (¹Embry-Riddle Aeronautical University, Prescott, AZ, ²Wichita State University, Wichita, KS)

The Airline Quality Rating is an objective method of assessing and ranking the quality of airlines based on the calculations of weighted performance criteria most important to the air travel consumer. The Airline Passenger Survey is conducted in order to obtain information such as airline preferences and perceived passenger friendliness through the collection of demographic variables, categorical data, as well as Likert-type scale responses based on the opinions of the flying public. Both studies are conducted using U.S. airlines with a minimum of 1% of domestic scheduled-service passenger revenue. The results of these studies reveal the discrepancies between calculated airline quality performance and the passengers' perceptions of the quality of airlines. The lack of consistency between passenger satisfaction reports and quantifiable airline performance can allow for key players within the airline industry to gain an enhanced understanding of the primary influences of passenger behavior.

NEXT GENERATION GENOME SEQUENCING AND MICROSATELLITE DEVELOPMENT OF THE LEECH *HELOBDELLA STAGNALIS

Kelsey Banister, Rebecca Beresic-Perrins and Stephen Shuster (Northern Arizona University, Flagstaff, AZ)

Despite being well studied for their ability to provide parental care, the relative tendency for the hermaphroditic leech, *Helobdella stagnalis*, to outcross or self-fertilize is poorly understood. Our previous experiments examining the life histories of individuals maintained in either isolation or mating pairs for the possible consequences between mating systems yielded only a single significant difference. In contrast to our predictions, the isolated individuals were shown to reproduce significantly earlier than those paired ($W[1, 0.05] = 8.065$, $p < 0.05$). However, these unusual results may be the outcome of events such as self-fertilization within mating pairs. To investigate the frequency of selfing, microsatellite markers are required. These markers will not only provide us with a means to assess parentage but allow us to determine the mode of reproduction as well as population homozygosity. Therefore, we are developing and executing a protocol for sequencing the genome of *Helobdella stagnalis*, from which we will identify the polymorphic microsatellites needed to develop reliable primers for genetic analysis. After evaluating various methods of sample preparation, Qiagen kits in combination with both bead and PCR cleanups provided the highest quality DNA. Furthermore, ITS gene sequencing was used to ensure our samples were not contaminated with foreign DNA prior to genome sequencing. Samples were prepared with Illumina Nextera XT prep kits and sequenced using Illumina MiSeq v3 chemistry. Future research will involve developing, optimizing, and applying these microsatellite primers to a large population possessing a known pedigree and life history record.

A NEW CYATHASPID GENUS (AGNATHA, HETEROSTRACI) FROM THE EARLY DEVONIAN OF THE WESTERN UNITED STATES

Jane Tucker and David Elliott (Northern Arizona University, Flagstaff, AZ)

Heterostracans are an extinct suborder of jawless, armored vertebrates known from Late Silurian and Early Devonian (418-395 million years ago) channel and near-shore environments. Cyathaspids, a major family within the Heterostraci, are recognized by the presence of continuous bony shields over the front half of the body comprising smaller growth areas (known as epitega) separated by sutures, an ornament of longitudinal dentine ridges, and the presence of a branchial plate. In this study a new Early Devonian (Emsian) cyathaspid genus is described from three species from the Early Devonian of California, Nevada, and Utah. The new species are medium-sized with an oval, broad, and flat dorsal shield and a deep and convex ventral shield. They differ from each other in size and details of the morphology of the posterolateral edge of the dorsal shield. Their overall appearance is similar to the genus *Boothiaspis* from the Late Silurian of the Canadian Arctic and the presence of a branchial plate (not confirmed in *Boothiaspis*) confirms their membership in the family Cyathaspididae.

Although the new species resemble *Boothiaspis*, there are key differences suggesting that they represent a new genus. Firstly, the suture anterior to the orbit that was thought to be characteristic of boothiaspids is lacking. Secondly, the sensory canal system of the new species comprise short, punctuated sections, a feature unknown within cyathaspids but which may be an advanced trait as it occurs in another heterostracan found at one of the same localities. Finally, the Canadian Arctic material is Late Silurian, while the western US material is late Early Devonian. It is assumed that the boothiaspids are ancestral to the new species as the arctic has been shown to have been a center of development and dispersal for the Heterostraci. However, it is not clear how heterostracans moved to the western US, although it was most likely by slow migration along coastal routes.

***THE ESTABLISHMENT OF PIERCE'S DISEASE AND INFECTION RATES OF XYLELLA FASTIDIOSA IN THE YAVAPAI COLLEGE VINEYARD**

Wayne Ciddio, Ariel Rosenfield, Justin Brereton and Kelly Trainor (Yavapai College, Prescott, AZ)

Recently, the introduction of a leafhopper in the southwestern US has led to the spread of Pierce's Disease, which is caused by the bacterium *Xylella fastidiosa*. This disease is highly transmissible between infected plants and leads to the eventual death of infected grapevines. As part of the Yavapai College Viticulture & Enology Program, there is a one-acre, three year old vineyard for the growing of wine grapes. The goal of our research is to determine the extent of *Xylella fastidiosa* infection in this vineyard through the use of Enzyme Linked Immunosorbent Assays (ELISAs) that allow the detection of bacterial proteins in infected plants.

***LONG-TERM CONSUMPTION OF RAW VS. COOKED DIETS & THE EFFECTS ON ORANGE HEADED COCKROACHES (*EUBLABERUS POSTICUS*)**

Megan Daubert and Jeb Bevers (Yavapai College, Prescott, AZ)

In our own species (*Homo sapiens*) cooked food is supported to have been critical by some authors (Wrangham 2009) in selecting for many modern adaptive traits. Cooking increased the value of

our food by pre-processing many of the molecules into a more readily digested and assimilated form. This ease of digestion and assimilation is supported to have greatly influenced the evolution of our fire using ancestors and produced several adaptive changes in our species. The goal of our research is to test these evolutionary adaptations on Orange Headed Cockroaches (*Eublaberus protius*) by comparing the consumption of raw versus cooked diets to see if these dietary constraints affect the species reproductive, growth, and life-cycle rates. Our results are minimal due to the lack of generational data. Other factors, such as the species pre-adaptation as survivalists and scavengers, may have been important in the inconclusive results.

UNDERSTANDING GROWTH AND DEVELOPMENT THROUGH THE INJURY RESPONSE IN *DROSOPHILA MELANOGASTER

Deanna Duprey, Matthew Burch, Dipul Patel, Audrie Santa Cruz and Jennifer Hackney (Arizona State University, Glendale, AZ)

Infections, disease, inflammation, and other injuries to specific tissues can cause many different effects on growth in humans, such as delays in development and the onset of puberty. In the fruit fly, *Drosophila melanogaster*, damage to imaginal discs, which give rise to adult appendages, triggers developmental delays (e.g. prolonged larva/pupal stages), the extent of which is influenced not only by the amount of tissue damage present but also the time of damage with respect to development. The aim of our research is to elucidate the mechanism behind injury-induced developmental effects in other specific tissues and at different developmental stages. This is done by inducing tissue damage via temperature-sensitive expression of cell-death genes specific to various tissues in *D. melanogaster* and monitoring the rate and amount of progressive development after injury. This allows for us to examine how injury to specific tissues influences time to pupariation and adult eclosion (emergence from pupal cases), as well as determine whether larval age at the time of injury influences the injury response. Preliminary findings have indicated mixed results of both delays and absent effects pertaining to injury response; this highlights the necessity and importance of further study. Understanding the relationship between *Drosophila's* injury response and our own could provide valuable insight on the mechanisms behind inflammation- and disease-induced defects in the onset of puberty in humans.

***IDENTIFICATION OF DIFFERENTIALLY EXPRESSED GENES AS BIOMARKERS FOR DIAGNOSIS OF IRRITABLE BOWEL SYNDROME (IBS)**

Christopher M. Dussik¹, Maryam M. Hockley¹, Marya S. Sabir¹, Ichiro Kaneko^{1,2}, Lin Zhang¹, Michael A. Galligan¹, Todd R. Sandrin¹ and Peter W. Jurutka^{1,2} (¹Arizona State University, Glendale, AZ; ²University of Arizona College of Medicine, Phoenix, AZ)

Irritable bowel syndrome (IBS) is classified as a functional gastrointestinal disorder due to its apparent lack of biochemical changes. In current practice, IBS can only be diagnosed through the systematic exclusion of other conditions with similar clinical indications and is thereby determined via symptomatic parameters classified as the “Rome criteria”. This process is extremely time

consuming and requires a significant investment of resources including escalating health care costs. A direct molecular diagnostic tool to identify IBS would be extremely valuable in order to reduce costs and promote positive patient outcomes. This project aims to discover genetic markers that could be utilized to detect IBS. Two independent gene microarray analyses involving 16 different tissue biopsy samples have been completed to date and used to select a series of genes in which significant variations exist between the expression levels found in IBS versus non-IBS colonic tissue samples. Via the use of bioinformatics, the pathways associated with a number of these genes were identified, and genes that could be associated with gastrointestinal inflammation were selected for further testing. The validity of the gene chip data was evaluated by employing qRT-PCR to measure the expression differences in the tissue samples exhibiting the highest degree of transcriptional variation for a respective gene. As an additional assessment of the validity of the gene chip results, qRT-PCR was utilized to determine the expression levels of pooled IBS patient RNA relative to those of a control non-IBS RNA pool. Based upon these data, five genes were selected for preliminary analysis of diagnostic efficacy. Initial investigation with known IBS patient RNA suggests the expression levels of these five genes may prove to be useful in the differentiation between IBS and non-IBS patients, with at least 76% correlation of gene expression to IBS phenotype. In summary, we have developed a preliminary screening tool, based on genetic expression profiling of key genes that displays potential diagnostic value in assessing the probability of IBS in a human patient population.

***MASS SPECTRUM PROCESSING PARAMETERS AFFECT STRAIN-LEVEL MALDI-TOF MS-BASED CHARACTERIZATION OF *PAENIBACILLUS LARVAE* ISOLATES**

Beau Grotgendick, Lin Zhang, Connie Borrer, and Todd Sandrin (Arizona State University, Glendale, AZ)

Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) is a rapid and reliable method to characterize bacteria at the species-level; however, characterizing bacteria at the strain-level can produce ambiguous results. The aim of this work was to evaluate the effect of mass spectrum processing parameters on strain-level resolution during MALDI-TOF MS-based characterization of *Paenibacillus larvae* isolates. A protein extraction sample preparation approach was used to obtain mass spectra from 12 isolates. Pre-processing settings, including baseline subtraction, noise computation and smoothing, in a commonly used bioinformatics software package (Bionumerics; Applied Maths) were adjusted using a common workflow. Dendrograms of these pre-processed mass spectra were constructed using both Pearson and Dice similarity coefficients. Jackknife and group violation analysis were conducted to quantify effects of these pre-processing parameters on taxonomic resolution. Using the Pearson similarity coefficient, an increase in the baseline subtraction rolling disc width parameter of 50 (default value) to 230 increased the jackknife value from 83% to 91%, and decreased group violations from 30% to 29%. With regard to the Dice similarity coefficient, an increase in the baseline subtraction rolling disc width parameter of 50 (default value) to 100 increased the jackknife value from 81% to 89% and decreased group violations from 58% to 55%. Preliminary results suggest noise computation and smoothing can also affect taxonomic resolution. Similarly, the effect of post-

processing parameters on taxonomic resolution was examined. Increasing Pearson curve smoothing from 0 to 1% increased the jackknife value from 83% to 97%, and decreased the group violations from 30% to 10%. Increasing the Dice minimum height from 20% to 30% increased the jackknife value from 83% to 97%, but no effect was observed for group violations. Overall, our results suggest that processing parameters used during MALDI-TOF MS characterization of *Paenibacillus larvae* isolates affected strain-level resolution. MALDI-TOF MS appears to be a rapid tool to characterize *Paenibacillus* and may afford more reliable strain-level resolution through additional optimizations of pre- and post- processing settings.

***ANALYSIS OF CALCIUM HOMEOSTASIS IN BUDDING YEAST**

Rosalind Huff, Jennifer Muir, Zinyada Nektalova and Pamela A. Marshall (Arizona State University, Glendale, AZ)

In our lab we are interested in studying calcium homeostasis. Calcium homeostasis within the cell is essential for many functions ranging from responses to cellular stress, fertilization, cardiac function, hormone secretion, and neurotransmitter stimulus. We use the budding yeast *Saccharomyces cerevisiae* as a model system to study fundamental questions about how cells respond to calcium. We are particularly interested in how cells respond to a single extracellular pulse of calcium. In wild type yeast, after we pulse the cells, the calcium quickly enters the cell and then is sequestered away in the vacuole and endoplasmic reticulum. One study we undertook was to determine if there were differences in the way the cells respond if the concentration of the extracellular calcium pulse was varied. In humans, even a minuscule change in calcium levels within the cytosol of a cell can have a devastating impact on the viability of that cell. Our data showed that after being pulsed with extracellular calcium, at approximately 30 seconds the cytosolic calcium levels within the cell had a sharp increase. In addition the increase in cytosolic calcium was proportional to the molarity of the calcium solution used to pulse the cells, with the exception of a larger increase in cytosolic calcium between 50mM and 60mM concentrations. We also synchronized the cells into the same phase of the cell cycle to see if we could analyze a more homogenous population and their response to an extracellular pulse of Calcium. This provided a better understanding of how cells react at different phases of the cellular cycle. Our data showed that synchronized cells responded differently than unsynchronized cells. Further studies will include a mathematical model of calcium homeostasis within the yeast cell and investigate the existence of more than one steady state of calcium levels.

***THE ANTI-AGING GENE, SIRT1, MODULATES VITAMIN D SIGNALING VIA CELL- AND PROMOTER-SPECIFIC PATHWAYS**

Zainab Khan¹, Marya S. Sabir¹, Mike Galligan¹, Angelika Dampf Stone¹, G. Kerr Whitfield², Mark R Haussler², and Peter W. Jurutka^{1,2} (¹Arizona State University, Glendale, AZ; ²University of Arizona College of Medicine, Phoenix, AZ)

Vitamin D, a bioactive lipid and essential nutrient, is obtained by humans through either endogenous synthesis in response to UV light exposure or via nutritional intake. Once activated to its hormonal form, 1,25-dihydroxyvitamin D (1,25D) binds to and activates the nuclear vitamin D receptor (VDR). Activation of VDR is known to modulate gene transcription in 1,25D target tissues such as kidney, colon, and bone; however, less is known about the ability of VDR to respond to "nutritional modulators". One such potential VDR modulator is resveratrol, a plant-derived polyphenol and potent antioxidant nutrient that also functions as a chemopreventative. Resveratrol is known to activate SIRT1, a deacetylase protein whose absence causes premature aging in SIRT1 knockout mice. Thus, we employed transcriptional assays to assess the influence of resveratrol and SIRT1 on the vitamin D signal transduction pathway in different cell lines. Specifically, embryonic kidney (HEK293), colon cancer (HCT116), glioblastoma (U87), and osteosarcoma (TE85) cells were utilized. The results revealed an increase in transactivation of the VDR pathway in the presence of SIRT1 and resveratrol in HEK293 and TE85 cells, while a decrease in transactivation was observed in HCT116 and U87 cells. Thus, the effects of these putative VDR modulators were determined to be cell-context specific. Additionally, the ability of SIRT1 and resveratrol to modify VDR transactivation via distinct vitamin D response elements (VDREs) found in the promoter regions of vitamin D target genes was evaluated in HEK293 cells utilizing transcriptional assays. It was determined that both of these prospective regulators independently increased transactivation of genes that utilize everted repeats (PER6) and direct repeats (XDR3) as VDREs; however, a SIRT1-mediated decrease in VDR-directed transactivation was observed with VDREs from the rat osteocalcin (ROC) and CYP24 promoters. Hence, the effects of resveratrol and SIRT1 on the VDR pathway are likely promoter specific. In conclusion, our novel results illustrate that the crosstalk between two nutritionally-derived lipids, 1,25D and resveratrol, and their protein mediators (VDR and SIRT1, respectively) are dependent on both cellular and promoter contexts. The impact of these unique observations is to advance our understanding of the novel role of VDR as a physiologically relevant nutritional sensor in human cells.

***VIRION STRUCTURAL METAPROTEOMICS SHEDS LIGHT ON OCEAN ‘VIRAL DARK MATTER’**

Eun-Hae Kim, [Gareth Trubl](#), J. Cesar Ignacio-Espinoza, Robert Jones, Nathan VerBerkmoes, Virginia I. Rich and Matthew B. Sullivan (University of Arizona, Tucson, AZ)

Microbes have critical impacts on biogeochemical cycles and are participants in most known energy-yielding pathways. A major challenge in meta-omic analyses is the lack of annotation for much of global sequence space. Specifically, most viral gene sequences have unknown function and the annotated genes are biased towards pathogens. This makes annotating new sequences difficult. To better understand Earth's biogeochemistry, we must be able to identify the functional capability of microbes. Here we apply high-resolution environmental metaproteomics to four purified viral concentrates from the Tara Oceans Expedition. Three different algorithms (Sequest version ORNL, Sequest HT (within Proteome Discoverer 1.4.1.14), and X! Tandem version CYCLONE (within the Trans-Proteomic Pipeline 4.6.3) were implemented to identify proteins

extracted from “wild” marine viral particles. Using matched metagenomic databases, we identified 990 proteins that are predominantly (71%) of unknown function, and which belong to 399 non-redundant protein clusters (89% of which are also unknown). These data help identify function for structure-associated proteins in known abundant tailed viruses and validate newly-identified uncultured viral sequences linked to abundant novel hosts. Protein clustering revealed 71 previously unknown proteins that can now be functionally annotated as virion-associated components (reducing unknown proteins from 71% to 64%). Cluster CAM_CRCL_773 alone comprised 22% of the identified structure-associated proteins, and structural modeling indicates its likely role as a novel, previously unknown capsid. Together these analyses provide necessary, culture-independent structure-associated protein annotations critical for identifying viral signals across diverse datasets to better elucidate viral roles in nature.

***STATISTICAL ANALYSIS OF MICROARRAY DATA: IDENTIFICATION OF DIFFERENTIALLY EXPRESSED GENES FOLLOWING INJURY IN THE FRUIT FLY**

Blake Landlais, James Howard, Rebecca Dern, Jennifer Hackney and Jennifer Broatch (Arizona State University, Glendale, AZ)

The fruit fly *Drosophila melanogaster* is among one of the most extensively studied organisms in genomic history serving as a robust model in studying human biology. Microarray technology and development has proven to be an efficient and cost effective method of gene expression analysis. Using freely available, open-sourced statistical software, we demonstrate an analysis of microarray data showing the most differentially expressed genes in the fruit fly following tissue injury. We compared the RNA of non-injured flies (control) to the RNA of flies that were injured prior to their pupic state (ablated). We aimed to detail which, if any, genes had been differentially expressed. Two samples of *D. melanogaster* microarray data, each containing 15,552 genes, were analyzed using R Statistical Computing software and standard bioinformatics protocol. A table of the thirty most differentially expressed genes was produced detailing gene-specific log-fold changes after tissue injury. This approach of utilizing open-sourced statistical software to analyze these microarray data suggests the feasibility of rapid and efficient identification of differentially expressed genes in many fields of study. Moving forward, the developed process can be applied to study the gene expression response to other types of tissue damage.

***YEAST RESPONSE TO ENVIRONMENTAL CALCIUM CONCENTRATION CYCLES**

Binh Nguyen¹, Hang Doan¹ and Francisco J Solis² (¹Arizona State University, Tempe, AZ; ²Arizona State University, Glendale, AZ)

In yeast and in many other organism’s cells, calcium is important for its role in enzymatic reactions and in volume control. Calcium homeostasis is therefore a crucial function of these cells. The response of yeast to sudden increments in environmental Calcium concentration is well studied. It is known that after an external concentration increase, the cells’ cytosol Calcium also quickly increases but is later reduced. The reduction is achieved by means of several processes that include, among others, Calcium sequestration into the vacuole. The response to cyclic changes in external

concentration is less well studied. Using chemiluminescence techniques, we investigate the cytosolic calcium concentration response to sequences of external Calcium concentration variations.

***CARBON RELEASE FROM SUBARCTIC LAKES**

Akosua Owusu-Domme*¹, Morgan Binder*¹, Robert Jones¹, Eun-Hae Kim¹, Martin Wik², Ruth Varner³ and Virginia I. Rich¹ (*these authors contributed equally to this work; ¹University of Arizona, Tucson, AZ; ²Stockholm University, Stockholm, Sweden; ³University of New Hampshire, Durham, NH)

Methane emissions from Arctic and sub-arctic lakes represent a significant pathway for carbon loss from their adjacent ecosystems. These emissions are rising due to increasing temperatures driven by climate change. Lake sediment microbial communities are mediating this carbon loss through diverse metabolic pathways, most notably methanogenesis. To improve understanding of microbial community relationships to *in situ* geochemistry and emitted methane, we compared microbial communities between two nearby lakes with contrasting low versus high emissions, with particular focus on methanogens. Specifically, we compared core profiles from four sediment samples taken at different depths from two lakes (Mellan Harrsjon and Inre Harrsjon) in sub-arctic Sweden, within a thawing permafrost ecosystem. DNA was extracted, and the 16S rRNA genes were amplified and high-throughput sequenced. We then used the open-source software, QIIME (Quantum Insights into Microbial Ecology), to analyze the diversity and composition of the microbial communities within these samples. Our results indicate that at shallower lake depths there is more variation in methanogens than at deeper depths. The shallow samples have higher relative abundances of reverse methanogens, acetoclastic (obligate) methanogens, while the deeper samples are dominated largely by hydrogenotrophic methanogens. Additionally, the shallow samples contain a higher relative abundance of the group RC-II, a group that contains a newly-discovered novel methanogen identified in the adjacent Mire. Both the shallow and deep samples contain a very high relative abundance of the group E2, a possible methanogenic lineage. We hypothesize that these results reflect a greater variation of substrates for methanogenesis in the shallow depths, while as lake depth increases substrates are more decomposed resulting in hydrogen being the most abundant final electron donor for the reduction of carbon dioxide. Analyzing the variation of methanogen types in these lakes not only sheds light into the ecology of these microbial groups, but also provides insight into the controls on greenhouse gas emissions from these dynamically changing systems, and may thereby improve climate models

DAMAGE TO LARVAL TISSUES AND ITS EFFECT ON DEVELOPMENTAL TIMING IN *DROSOPHILA MELANOGASTER

Alicia Ripper, Bree Caldera, Brandi Mead-Smith and Jennifer Hackney (Arizona State University, Glendale, AZ)

During development, organisms undergo important changes that prepare them to become healthy adults. Damage and severe inflammation alter steroid hormone production and can disrupt the timing of developmental transitions such as puberty. In the fruit fly, *Drosophila melanogaster*, injury to wing precursor tissues results in decreased steroid hormone levels and

delayed development. The effects of damage to other tissues have not yet been explored. Here, a variety of other *Drosophila* tissues were damaged in order to observe how injuring those tissues affect the timing of developmental transitions. Damage was triggered by tissue-specific, temperature sensitive activation of cell death genes. Preliminary results indicated that death to various organs may either accelerate or delay development. Insight into the effects of injury on development in *Drosophila* can potentially lead to information about development in other organisms, including humans, following injury or chronic inflammation.

ELUCIDATION OF CHANGES IN METABOLISM AND GENE EXPRESSION IN RESPONSE TO LOCALIZED TISSUE DAMAGE IN *D. MELANOGASTER

Jesús Contreras Rodríguez^{1,2}, Ty Leek¹, Sabahat Hussain¹, Jennifer Broatch¹ and Jennifer Hackney¹ (¹Arizona State University, Glendale, AZ; ²Arizona State University, Tempe, AZ)

Organisms that suffer tissue damage during development must undergo delay and allocate resources toward correcting injuries before proceeding toward later stages, otherwise complications may rise later in development and death may ensue. The mechanisms underlying this phenomenon are largely unknown. It is likely that localized injury leading to developmental delays will up-regulate anabolic pathways and increase the energy needs of the organism. We are using changes in gene expression following wing precursor tissue damage in third instar larval stage in *Drosophila melanogaster*, commonly known as the fruit fly, as a model to understand the response to injury during development. We seek to identify the genes that are differentially expressed following injury. Identification of genes displaying changes in expression will be made using microarray analysis of total RNA isolated from whole larvae. Understanding the changes in gene expression and metabolic changes in injured larvae can lead to a greater understanding of complications that develop early in development of complex Eukaryotes.

***INFLUENCES ON NATIVE AND INVASIVE GRASS DENSITY ALONG FIRST CREEK TRAIL IN RED ROCK CANYON NATIONAL CONSERVATION AREA**

Alexander D. Russell¹, Maria Isabella Aquino¹ and Brian C. Wainscott² (¹University of Nevada Las Vegas, Las Vegas, NV; ²College of Southern Nevada, Las Vegas, NV)

The density of a native grass species (*Bouteloua barbata*) and an invasive grass species (*Bromus rubens*) was recorded along the First Creek Trail (FCT) within Red Rock Canyon National Conservation Area (RRCNCA) to determine how grass density is influenced by local fire history and distance from a recreational trail. We also explored the influence a prolific bloom of the summer annual *B. barbata* had on the density of the winter annual *B. rubens*. Grass density was determined by counting the number of tuft remains of *B. barbata* from the previous year and the number of stems of *B. rubens* in 66 randomly selected 1-m² sample plots, half of which were located in a recently burned area and the other half in a historically burned area. We compared grass density between sample plots within recently and historically burned areas using one-way ANOVA for *B. rubens* and Mann-Whitney U Test for *B. barbata*. *B. rubens* density was significantly greater (F=16.558, p=0.000) in historically burned plots whereas *B. barbata* density

did not differ significantly based on fire history ($p=0.583$). We used linear regression analysis to determine how much of the variation in grass density could be explained by distance from FCT. None of the variation in *B. rubens* density was explained by distance from the trail ($r^2=0.001$) whereas nearly one-third of the variation in *B. barbata* density was explained by distance from the trail ($r^2=0.291$). The latter relationship was stronger in historically burned plots ($r^2=0.478$) than recently burned plots ($r^2=0.112$). We also used linear regression analysis to determine how much of the variation in *B. rubens* density could be explained by the density of *B. barbata*. None of the variation in *B. rubens* density was explained by *B. barbata* density ($r^2=0.001$) along the FCT in RRCNCA.

***VITAMIN D AND RESVERATROL: A FOUNTAIN OF YOUTH IN GENE REGULATION**

Marya S. Sabir¹, Zainab Khan¹, Michael A. Galligan¹, Angelika Dampf-Stone¹, G. Kerr Whitfield², Mark R. Haussler², and Peter W. Jurutka^{1,2} (¹Arizona State University, Glendale, AZ; ²University of Arizona College of Medicine, Phoenix, AZ)

Vitamin D, acquired via dietary sources or upon exposure to ultraviolet radiation, is endogenously converted to the physiologically active secosteroid, 1,25-dihydroxyvitamin D (1,25D). 1,25D initiates a myriad of bioeffects by binding to the nuclear vitamin D receptor (VDR) and driving heterodimerization of VDR with the retinoid X receptor (RXR). The liganded VDR-RXR complex modulates gene transcription in 1,25D target tissues, including the kidney and colon; thus regulating immune defenses, bone mineral homeostasis, and control of epithelial cell proliferation, differentiation, and chemoprevention. The significance of vitamin D in the numerous facets of health stresses the importance of elucidating the molecular network by which 1,25D, as well as VDR signaling modulators function cooperatively to regulate gene expression. Resveratrol (Res), a natural polyphenolic phytochemical and antioxidant, is one such putative VDR modulator. Res functions as a potent activator of NAD-dependent deacetylase sirtuin-1 (SIRT1), an enzyme associated with longevity in animal models. The current study employed mammalian-two-hybrid (M2H) and VDRE-based transcriptional assays to investigate the potential effects of resveratrol and SIRT1 on VDR signal transduction. Results from the VDRE-based assays indicated that Res and SIRT1 could potentiate 1,25D-VDR activity. In addition, vitamin D displacement experiments revealed an increase in VDR-bound radiolabeled 1,25D only in the presence of Res, suggesting that Res may increase VDR transactivation by stimulating 1,25D binding. M2H assays in embryonic kidney (HEK-293) cells were utilized to examine additional molecular mechanisms by which Res and SIRT1 may enhance VDR activity by assessing levels of physical interaction between VDR and VDR comodulators, including RXR, SRC-1, and DRIP-205. Both Res and SIRT1 increased the ability of VDR to associate with RXR and SRC-1; however, DRIP-205 interaction was not enhanced. Additionally, the specificity of SIRT1 action towards various nuclear receptors, specifically VDR, ER, and LXR was probed, and only VDR and ER exhibited SIRT1 stimulation. A specific SIRT1 inhibitor, EX-527, was used to suppress endogenous SIRT1 levels resulting in decreased VDR transactivation. To analyze the acetylation status of VDR, the activity of a novel, non-acetylatable VDR mutant, K413R, was probed in VDRE-luciferase assays.

Significantly, the K413R mutant demonstrated amplified transactivation in contrast to wild-type VDR. In summary, the findings of this study illuminate the coordinated interaction between two nutritionally-derived lipids, vitamin D and resveratrol, thereby identifying a link between 1,25D-VDR signaling and SIRT1 function; thus establishing the significance of resveratrol to human nutrition and aging.

***IDENTIFICATION OF THREAT FACTORS IMPACTING 141 FISH SPECIES OF SPARIDAE FAMILY PRESENT GLOBALLY**

Dennis Sanchez, Beth Polidoro and Jennifer Broatch (Arizona State University, Glendale, AZ)

IUCN (International Union for the Conservation of Nature) plays a prominent role in guiding conservation activities of governments, Non-Governmental Organizations (NGOs), and scientific institutions. The IUCN Red List is the most comprehensive global approach for evaluating the conservation status of plant and animal species. The conservation status consists of Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concerned and Data Deficient. The data used for our analysis was collected from the Species Information Service. IUCN Red List uses this information management tool to facilitate all of species data from the workshops to published data on the website. We used this tool to extract the database containing all of the data collected by IUCN on the species of interest. The objective my research was to identify important threatening factors of 141 species from the Sparidae family. Using a random forest model with 500 classification trees and species data from the Sparidae family, we were able to predict species' Red List category with a 15.57% error rate. We analyzed what variables had the largest importance and found that factors such as population trend, extend of occurrence, and longevity were the most important factors in the predictions. With more time, we expect to include non-biological traits of the species to investigate further into important threatening factors.

***YEAST TWO HYBRID ANALYSIS OF RXR LIGANDS**

David Seto, Vanessa Hayes, Julia Varkey, Peter W. Jurutka, Carl E. Wagner and Pamela A. Marshall (Arizona State University, Glendale, AZ)

Bexarotene (Targretin®) is an FDA approved drug used to treat cutaneous T-cell lymphoma (CTCL), as well as off-label treatments for other cancers and Alzheimer's disease. Previous research has indicated that bexarotene has a specific affinity for retinoid X receptors (RXR), which allows bexarotene to regulate RXR and in return alter cell differentiation and proliferation. This study uses the Yeast Two-Hybrid (Y2H) system to measure the level of Beta-galactosidase transcription activity based upon successful RXR homodimerization after transformed *Saccharomyces cerevisiae* L40 are treated with bexarotene analogs. We compared protein interactions of fourteen different analogs to bexarotene. Preliminary results indicate that eight of the fourteen analogs may potentially bind better to RXR than bexarotene. This higher affinity for RXR may help scientists identify a compound that will minimize side effects of bexarotene and serve as a better cancer treatment alternative.

***CHARACTERIZATION OF NEXT GENERATION NOVEL RXR SELECTIVE AGONISTS TO COMBAT CANCER AND NEURODEGENERATIVE DISEASES**

Pritika Shahani¹, Carl Wagner², Pamela A. Marshall², Ichiro Kaneko¹ and Peter W. Jurutka^{1,2}
(¹Arizona State University, Glendale, AZ; ²University of Arizona College of Medicine, Phoenix, AZ)

Retinoids are a group of compounds that are derived from vitamin A and have a vital role in epithelial cell growth. Retinoids are often used in clinical treatment of specific cancers and some forms of skin diseases. A synthetic analog of vitamin A, namely Bexarotene (Bex), is currently used to treat cutaneous T-cell lymphoma (CTCL). Bex binds to the retinoid X receptors (RXRs) and stimulates RXR homodimerization and activation of RXR target genes. Bex also impacts RXR heterodimerization with other nuclear receptors, including the liver-X-receptor (LXR). It was recently shown that Bex, via RXR-LXR, can induce ApoE expression and reverse beta amyloid (A β) plaques in mouse models of Alzheimer's disease. Therefore, in the current study, we synthesized novel next generation RXR analogs that were modeled after Bex. These compounds included various structural modifications in an attempt to create synthetic ligands that have high affinity for RXR and thus promote the activation of both RXR-RXR-controlled genes for anti-cancer action, as well as RXR-LXR-mediated genes like ApoE to help reduce A β plaques. The synthesis and testing of these high affinity analogs allows for their eventual clinical use at lower concentrations, thus potentially reducing some of the side effects associated with high-dose Bex therapy. Moreover, studies have demonstrated that RXR selective molecules can be manufactured to favor RXR activation over retinoid acid receptor (RAR) interactions; thus, preserving the anti-cancer response without increasing the corresponding side effects induced by RAR activation. The testing of these novel Bex analogs involved the use of two screening assays to assess their activity. The first was the mammalian two-hybrid assay (M2H), which determines if the analogs can bind RXR and induce subsequent RXR homodimerization, a prerequisite step in the activation of RXR genes. The M2H screen is followed by a second assay that employs an RXR responsive element DNA sequence (RXRE) which determines analog activity in the more natural setting of the RXRE DNA platform. Results from these assays revealed that our new generation of analogs consists of a spectrum of compounds, some of which bind to RXR with higher affinity while others bind with lower affinity. We are also currently testing these analogs for RAR activity. These results suggest that further modification of Bex may produce additional retinoids with enhanced biological profiles capable of combating cancer and Alzheimer's disease without dramatic side effects.

AIRBORNE ATMOSPHERIC RESEARCH FOR EDUCATION AND SAFETY

Melanie Wetzel, Dorothea Ivanova, Brent Bowen and Erin Bowen (Embry-Riddle Aeronautical University, Prescott, AZ)

Embry-Riddle Aeronautical University (ERAU) campus in Prescott, Arizona conducted an aircraft-based measurement program to introduce students in meteorology, aeronautical science and safety science to airborne scientific research technology and research flight logistics. The

ERAU Department of Meteorology was awarded a grant from the National Science Foundation (NSF) Division of Atmospheric and Geospace Sciences for an educational deployment of the University of Wyoming King Air (UWKA). The UWKA is an instrumented research aircraft providing atmospheric measurements and data relevant to study of aviation safety factors such as turbulence and airframe icing. Student and faculty researchers were engaged in flight missions, instrument system training, flight forecast simulations and follow-up data analysis. Project activities blended flight coordination, atmospheric measurement technology, airborne monitoring strategy, instrument design, aeronautical engineering, aviation safety and global security applications.

NEW PETALODONT SHARKS (CHONDRICHTHYES, ELASMOBRANCHII) FROM THE MIDDLE PENNSYLVANIAN OF ARIZONA AND NEVADA

Franceska Sena and David Elliott (Northern Arizona University, Flagstaff AZ)

Petalodontiformes are a diverse and widespread order of extinct Paleozoic marine chondrichthyans. They are known mostly from isolated teeth as their skeletons are cartilaginous and so do not preserve well. New species from the Middle Pennsylvanian (306-311 million years ago) Naco Formation in Arizona and Bird Spring Formation in Nevada are representatives of the family Pristodontidae, which characteristically had one upper and one lower tooth, although in some cases this could be a large tooth that extended along the jaw rami. The upper tooth bore a series of triangular cusps while the lower dentition consisted of a single monocuspid tooth. This unique dentition was presumably adapted for a specialised lifestyle. The large occlusal surface and shearing ridges on the lingual side of the teeth suggest adaptations for biting and slicing soft tissue rather than shelled organisms. It has been suggested that they fed preferentially on cephalopods but this has not been substantiated.

The Naco species bears cusps that are extremely thin, which is unique within the family. However, in all other respects it is similar to the previously described genus *Peripristis* and so is considered to be a new species within that genus. The new petalodont from Nevada on the other hand has characteristics unlike any other species within the family Pristodontidae. While it is still multicuspid and has a broad root much like other pristodonts, the root is bifurcated and the cusps consist of two large median cusps and smaller lateral cusps. This clearly indicates that it is a new species, the unique specimen representing an upper tooth. Petalodonts are a widespread group of fishes during the Paleozoic and are known from localities across the United States and from Western Europe. Although these two new species are unique to Arizona and Nevada they increase the known diversity and distribution of the family in the Pennsylvanian of the western United States.

12:00-1:30 AWARDS LUNCHEON/ANNUAL BUSINESS MEETING: LOBBY

ACADEMY BUSINESS AND ANNUAL REPORTS

OFFICERS 2013-2014

ELECTED

Pamela Marshall.....	President
Angela Schwindeman	Membership Secretary
Pedro Chavez	Permanent Secretary
Karen Conzelman.....	Treasurer
Robert Bowker.....	Recording Secretary
Theodore Manno.....	Director, Southern Arizona
Aregai Teclé.....	Director, Northern Arizona
Boris Poff.....	Director, Nevada
Brian Wainscott	Director at Large

APPOINTED

Robert McCord	Editor, Journal
Florence Slater	Editor, Proceedings
Karen Conzelman.....	Science Olympiad/Science Bowl Liaison
Theodore Manno.....	Editor, Newsletter
Karen Conzelman.....	Webmaster

SECTION CHAIRS

Robert Bowker.....	Biology
Robert McCord	Geology
Daniel Neary.....	Hydrology
Shafiu Jibrin.....	Mathematics/Physics
Pamela Marshall.....	Posters

PRESIDENT'S REPORT

It has been another excellent year for the Arizona Nevada Academy of Science. We reinvigorated our science with a joint meeting with the Pacific AAAS in Las Vegas for our annual meeting. We made excellent connections and had a wonderful time. Thanks so much to the Pacific AAAS for inviting and hosting us. We also published two volumes of the Journal, highlighting historical science in the Southwest, with two excellent articles chronicling the field notes of Herbert Brown, Arizona's Pioneer Ornithologist. The journal also contained research articles on flash flooding in the western United States and volcanic geology of the Batamote Mountains.

The journal is found at:

<http://www.bioone.org/loi/jana>

And archives are located:

<http://www.jstor.org/action/showPublication?journalCode=jariznevaacadsci>

Many thanks to Anthony Brazel who was the editor of our Journal for many years and will remain our AAAS Representative. He has passed the reins of the Journal on to Robert McCord and I am looking forward to more excellent scholarship in our esteemed pages.

Our electronic presence continues to grow. Since the Journal of the Academy has been on BioOne and JSTOR, many more scientists have been reading and citing our papers, as indicated by electronic "hits" and citations. This year, in partnership, with University of Arizona, we completed the digitally archiving of the Annual Meeting and Hydrology Proceedings in a searchable open access repository:

<http://arizona.openrepository.com/arizona/handle/10150/293741>

I want to especially thank Karen Conzelman who spearheaded this effort along with Kimberly Chapman, Campus Repository Service Manager, Assistant Librarian, Scholarly Publishing and Data Management Team (SPDM) at the University of Arizona Libraries. I also would like to acknowledge Pete Ffolliott for donating his entire collection of hydrology proceedings (*Hydrology and Water Resources in Arizona and the Southwest*) to the project for scanning; without his contribution, we would not have had the complete digitized archive we have today.

This meeting at NAU is an excellent opportunity for the Academy to showcase science in the southwest and there are many excellent poster and presentations. I am especially excited because there are so many student presentations this year. Many thanks to Aregai Tecele and Shafiu Jibrin and all of NAU for hosting us.

Please update your bookmarks/favorites with our new shorter URL: <https://www.aznvas.org>

I remind you of our Mission:

“The purpose of this Academy shall be: to stimulate scientific research and education; to disseminate scientific knowledge in the various fields of science; to promote fraternal relationships among those engaged in scientific work; to assist in developing and in making known the material and other resources of these two states; to encourage the publication of reports of scientific investigations; and to unify the scientific interests of the region.”

and encourage each Academy member to embrace our mission and consider how you might get more actively involved. Some suggestions are to recruit members, submit a manuscript to the journal, suggest the journal to a colleague, apply for one of our grants, volunteer to play an active

role in the Academy (just email me, and we'll find a place for you to help the Academy), and/or run for a board position in the Academy. We are always looking for people who want to assist in the Academy. I also encourage those of you who are just now becoming familiar with all the good work of ANAS to become a member (<https://www.aznvas.org/2joinanas.html>). In addition to becoming part of this historic institution (the Academy was founded in 1956!), membership affords you several benefits including a subscription the journal as well as discounted meeting registration and publication page charges.

Pamela Marshall
President

MEMBERSHIP REPORT

We currently have a total of ninety-nine ANAS members that includes fifty dues-paying members and forty-nine emeritus or life members.

Angela Schwendiman
Membership Secretary

NECROLOGY REPORT

Thomas K. Todsén (October 21, 1918-December 30, 2010)

Dr. Todsén received his Ph.D. in organic chemistry from the University of Florida. A veteran of World War II, Dr. Todsén taught at University of New Mexico, Las Cruces. He then was hired as a chemist at White Sands Missile Range; he designed the Range's first chemical laboratory. Tom then turned his full attention to pursuing his varied interests in Arizona/New Mexico postal history; hiking around the U.S., Mexico and Central America in search of wild orchids; and wildflower photography. Several of his photographs appear in the 15 volume set Wildflowers of the United States. He discovered a new species of fossil snail, and a new wildflower that bears his name: Todsén's pennyroyal (*Hedeoma todsenii*).

Richard Hevly (July 26, 1934 - October 31, 2008)

Dr. Hevly was a Botany professor at NAU from 1966-1999, having received his doctorate at the University of Arizona. Dick had strong research interests in Palynology and his work was focused on the Colorado Plateau. He worked with investigators from a broad range of disciplines including archaeology, geology and anthropology. His last work was the publication of the field notes of Dr. Samuel Woodhouse, which chronicles the plants, animals and peoples encountered on an exploratory expedition of the southwest in 1851.

Donald Hoffmeister (21 March 1916 - 6 February 2011)

Although Dr. Hoffmeister was a Professor of Zoology and Director of the Museum of Natural History at the University of Illinois, he had a particular interest in the southwest. He collected over 25,000 specimens from throughout Arizona and wrote *Mammals of Arizona* (1986). A comprehensive biography was published in *Journal of Mammalogy*, 93(3):871-878. 2012.

Karen Conzelman
Necrology Committee

**MINUTES
OF THE ANNUAL BUSINESS MEETING
AND AWARDS LUNCHEON**

June 17, 2013

The annual business meeting of ANAS was called to order at 12:30 pm at the University of Nevada, Las Vegas by President- elect Pamela Marshall. Attendees were: Pamela Marshall (PM, president), Karen Conzelman (KC, Treasurer), Florence Slater (FS, Proceedings Editor), Rob Bowker (RB, Interim Recording Secretary), Theo Manno (TM-Southern AZ Director, Newsletter Editor), Bob McCord (BM-Past President), Tony Brazel (TB-JANAS Editor), Boris Poff (BP-Nevada Director), Brian Wainscott, Aregai Tecele (AT-Northern AZ Director).

General Introductory Statement by New President Pam Marshall. ANAS President Shafiu Jibrin was unable to attend the annual meeting due to family emergency that had him out of country; therefore, President-Elect PM would be conducting the meeting.

PM stated that Lara Ferry (ASUW) was going to work with her this year on keeping the ANAS Facebook page more current. An additional initiative of hers is to spread the word regarding ANAS high school, undergraduate, and graduate student grants-in-aid with the hope of getting more applications. Board plans to review whether it would be more effective to try offering fewer larger grants. She also plans to contact the four state universities (ASU, UA, NAU, and UNLV) to see about getting the Bud Ellis scholarship for high school students announced on their scholarship web pages.

Minutes from 2012 Meeting and Reports of Officers are normally included in the Proceedings and reviewed at this point in the business meeting, but because of the unique joint nature of this meeting (with AAAS-Pacific Division), the ANAS Proceedings have not yet been published. Thus, written reports will be made available to members online and any corrections solicited by e-mail. Barring any significant dissent within a fixed time period, the reports will be considered approved.

Honorary Fellows. Bob McCord announced the members nominated as 2013 Fellows (Pamela Marshall and Shafiu Jibrin) and read their credentials that demonstrated support for their selection. Nominees were approved by members in attendance. Certificates were presented. Pam and Shafiu's biographies will be included in the Proceedings.

Old Business- None

New Business

- 1) By-Law Changes: TM has recommended some grammatical edits to the by-laws; however, they could not be voted on at this meeting because (per by-laws) any proposed changes must be sent to the membership 60 days prior to the business meeting. TM will make sure they are distributed in advance of next year's meeting.
- 2) Committee reports. Pete Ffolliott was announced as the Outstanding Service Award Winner for 2013-2014. His bio will appear in the Proceedings. Since Pete was unable to

attend the meeting due to other commitments, KC will send him his plaque and gift card along with a copy of the Proceedings and a letter of congratulations.
The Student Travel Award winner was Jennifer Kepler from ASUW.

3) Election of Officers.

Nominations for Open Positions:

- a. President Elect-no nominees
- b. Membership Secretary-Angela Schwendiman
- c. Recording Secretary-Robert Bowker
- d. Central Arizona Director – Boyd Campbell
- e. Director at Large-Brian Wainscott (Southern Nevada College) agreed to run for this position after having the responsibilities of the office described for him (recruiting papers to journal, attempting to draw in more members, attending board meetings, sharing important regional scientific news, and generally promoting the Academy).

Nominees were elected and other current officers were approved to continue their existing roles by acclamation. (KC-Treasurer, TB JANAS Editor, TM-So AZ Director, AT-Northern AZ Director, BP-Nevada Director, KC Science Olympiad Representative).

- 4) FS will put together a brief Proceedings volume with annual reports along with reprinting of abstracts of papers and posters by ANAS members and/or their students.
- 5) Journal Editorship: TB will continue in this role through Volume 45 and then wishes to pass the editorship to someone else. It would be good to find that person now so that there could be some overlap between Tony and the new editor. BM said he might be interested. He has some prior editorial experience. He and Tony will talk further before he makes a commitment. KC and TB think that Cindy Zisner is willing to continue as Production Editor.

The meeting was adjourned by President- elect Marshall at 1:30.

Robert Bowker
Recording Secretary

OUTSTANDING SERVICE AWARD

ANTHONY BRAZEL

This year the Academy celebrates the service of Anthony Brazel as the editor of the *Journal of the Arizona Nevada Academy of Science* from 2000-2006 and from 2008-2014. While Tony was recognized with this award in 2007, the committee felt that his contributions to the Academy were significant enough to merit additional note.

Tony has actually been a member of the ANAS Board of Governors for 20 years. He started as Central Arizona Director in 1994 and then served as President/Past-President from 1997-1999. As editor, Tony was instrumental in getting the journal back into a biannual production cycle. This publication consistency helped to raise the journal's profile and regard in the scientific community. Consequently, *JANAS* is now attracting manuscripts in sufficient quantity and quality to sustain that regular cycle of issues. The journal is one of the Academy's most important endeavors with an over fifty yearlong legacy; Tony's leadership has been critical to its endurance.

Tony's contribution to the scientific literature and public policy as a geographer and climatologist are also significant. He has written over 100 professional articles and reports on climate, focusing primarily at the local and regional scale. He has held multiple leadership positions and has helped to guide the training of numerous graduate students during his tenure at ASU. His retirement from the university has not slowed down his involvement in the scientific community; he is still on several grants, teaching and making presentations. Unfortunately, Tony could not join us today because he is presenting two papers and is an invited discussion panelist at the annual meeting of the Association of American Geographers conference this week.

BUD ELLIS SCHOLARSHIP

The Bud Ellis Scholarship of \$1000 is offered to a graduating senior from an Arizona or Nevada high school or preparatory school. This one year scholarship award is made to a student with an outstanding high school academic record who intends to enter one of the institutions of higher learning in Arizona or Nevada the following year as a science or engineering major.

Applications are limited to students in the top ten percent of their class who plan to continue in a field of science. In each case, the cash award is sent to the college or university of the winner's choice and accredited to his/her account. The amount of the scholarship is not affected by any other scholarships received.

The winner of the Bud Ellis Scholarship for 2014 is **Taylor J. Schwartz**, where she ranks first in her high school class of 227 students at Albert Lowry High School in Winnemucca, NV. There Taylor has earned an un-weighted GPA of 4.0 and has secured combined SAT scores of 2080, as well as an ACT score of 31. She has taken the full range of AP mathematics courses at her school through calculus, has excelled in honors courses in Biology, Physics and Spanish and is a member of the National Honor Society. She has been involved in volleyball, basketball and softball, lettering in the latter two sports and serving as captain in both. She has received all conference honors and is a member of the Nevada Academic All-State team. Taylor has received the enthusiastic support of her instructors, counselors and community members. Taylor plans to attend the University of Nevada, Reno to study civil or biomedical engineering.

Congratulations, **Taylor Schwartz!**

Stephen M. Shuster
Bud Ellis Scholarship Committee

SCIENCE BOWL/SCIENCE OLYMPIAD REPORT

One of the Academy's goals is to stimulate scientific research and education and thereby help to foster the development of the next generation of scientists. An aspect of that commitment is our affiliation with the regional tournaments of two high school academic programs: the Science Olympiad and the Science Bowl.

Science Olympiad (<http://www.gccaz.edu/biology/so>).

Since its inception in 1989, this statewide competition has celebrated the achievements of young people in the sciences and mathematics. The program challenges students to stretch their minds beyond the scope of typical science courses. Many alumni credit the intellectually engaging events of the Science Olympiad with keeping them interested in STEM-related disciplines and careers.

Thirty-two teams from 27 high schools competed in the 2014 state tournament on March 1st at Glendale Community College. Among the 25 events this year were Circuits, Elastic Launched Glider, Experimental Design, Forensics, Materials Science, and Water Quality. Some of these tested the participants' factual knowledge but many incorporated laboratory, technical and reasoning skills. (A complete list of the 2014 events with descriptions can be found at <http://www.gccaz.edu/biology/so/tournament14.html>).

Student testing his "Boomilever" to see how much suspended weight it can support without breaking. Rankings are based on the devices' relative load efficiencies.

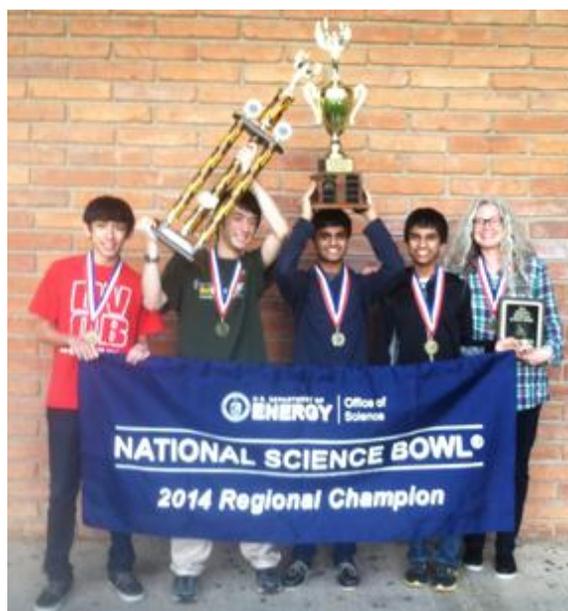


While the tournament is just one day, preparing to compete requires considerable advance planning. For example, some engineering-type events require students to design and construct a device to be tested on-site while others necessitate that students independently learn as much as they can about a subject not taught in most high schools. As is typical of "real world" science, the students work collaboratively on their projects. The 2014 tournament will be remembered for its stormy weather; however, even the rain could not dampen the enthusiasm of these kids. The awards ceremony brought the day to a boisterous conclusion. The teams' accomplishments were recognized with medallions and ribbons presented for 1st through 7th place in each of the events. All the individual scores were in turn combined to rank the top tiered teams overall (Score sheets can be found at:

<http://www.gccaz.edu/biology/so/images/olympiad2014scores.pdf>). Catalina Foothills High School from Tucson repeated as the State Champions and will represent Arizona at the National Tournament at the University of Central Florida in Orlando in May. Once again, the Academy donated special prizes in memory and honor of Dr. Bud Ellis to top placing teams in two events (Dynamic Planet and Entomology) as well as supply money to the club accounts of five schools competing in Phyloinformatics and in MagLev. In addition to ANAS' financial contribution, several of our members (Robert Bowker, Pedro Chavez, Pamela Marshall, Florence Slater) joined an army of other community volunteers to help to run the tournament. The 2015 tournament is planned for the first Saturday in March. Anyone interested in assisting next year should contact Karen Conzelman, State Site Director.

Arizona Regional Science Bowl (<http://www.wapa.gov/dsw/scibowl/>)

On the same day, GCC was also host to the twenty-eight teams participating in the Arizona Regional High School Science Bowl. The competition in this "Jeopardy"-style tournament was fierce, but Desert Vista ultimately won bragging rights and the opportunity to compete at the national level. Winners from left: Connor Vuong, Gen Fitzgerald, Rajeev Parvathala, Sanjeev Murty and Coach Birgit Musheno.



Every year schools from throughout the region vie in this double-elimination tournament for first place and the opportunity for an all-expense paid trip, sponsored by the Department of Energy, to the National Science Bowl Competition held in Chevy Chase, MD. The Science Bowl is a proven tool that encourages high school students to excel in math and science and to pursue careers in those fields. By raising the visibility of academic achievement in the sciences, the program has been successful in placing these young people on a par with their peers who excel in athletics.

Agripina Paluch, State Director, Arizona Science Olympiad

Karen Conzelman, State Site Director, Arizona Science Olympiad

Krystall Valencia, Arizona Regional Science Bowl

Treasurer's Report 2013

Operating and Short Term Reserve Fund (Vanguard Prime Money Market Fund)

Account Value on 12/31/12	\$27,014.23
Dividend Deposits	\$5.25
Account Value on 12/31/13	\$27,019.48

Goethe Educational Endowment Fund (Vanguard Index 500 Mutual Fund)

Account Value on 12/31/12	(236.866 shares at \$131.37/share)	\$31,117.09
Deposits (Contributions) +0 shares	Total: 236.866 shares	
Dividends +4.846 shares	Total: 241.712 shares	
Account Value on 12/31/13	(241.712 shares at \$170.36/sh	\$41,178.06

General Fund

December 31, 2012 Balance	\$16,650.59
Deposits	\$11,076.27
Expenses	(\$3,689.13)
Transferred to ASU General Fund	(\$1,500.00)
Transferred from ASU General Fund	\$130.09
December 31, 2013 Balance	\$22,667.82

ASU General Fund

December 31, 2012 Balance	\$401.09
Transfer from General Fund	\$1,500.00
Transfer to General Fund	(\$130.09)
Expenses	(\$1,771.00)
December 31, 2013 Balance	\$0.00

Science Olympiad General Fund

December 31, 2012 Balance	\$76,898.47
Deposits	\$22,073.76
Expenses	(\$25,352.22)
December 31, 2013 Balance	\$73,620.01

Science Bowl General Fund

December 31, 2012 Balance	\$2,217.17
Deposits	\$0.37
Expenses	(\$1,103.42)
December 31, 2013 Balance	\$1,114.12

Market Value of Assets (as of December 31, 2013) \$165,599.49

General Funds Details

<u>Deposits</u>		<u>Expenses</u>
\$2,080.00	ANAS Membership dues	
	PayPal charges	33.75
	Postage	
	Journal:	
770.00	Subscriptions	
	Refunds	
7,806.57	BioOne Royalties	
32.00	Sale of Back Issues	
330.00	Reprints/Page Charges	
	Printing	1,437.87
	Typing	1,500.00
	Postage	333.13
	Hydrology Proceedings	
	Other	
57.70	Royalties from book	
	Web hosting fee	227.82
	Scholarships:	
	Grants-in-Aid, High School:	
	Grants-in-Aid, Graduate	
	Grants-in-Aid, Undergraduate	
	Science Olympiad awards	1,100.00
	Annual Meeting:	
	Registration Fees	
	PayPal Charges	
	Sponsor donations	
	Proceedings, Printing	119.13
	Proceedings, Postage	11.20
	Coffee Breaks	
	Friday Reception	
	Saturday Luncheon	
	Meeting Rooms/Equipment	
	Awards	
	Outstanding Service	50.00
	Outstanding Teacher	
	Printing/Postage	
	Plaques	20.94
	Student Travel Grants	475.00
	Goethe Endowment Fund Contributions	
	AZ Corporation Commission	10.00
	NAAS Dues	75.00
	Supplies	
	Postage/Office	18.13
	Printing/Office	48.16
	Board Meeting Refreshments	
	Bank Charges	
	Interest	
	Other	
\$11,076.27	SUBTOTAL	\$5,460.13

<u>Deposits</u>		<u>Expenses</u>
	Science Olympiad	
\$20.76	Interest	
15,598.50	Sponsor donations	
5,618.00	Membership dues	1,600.00
	Tournament	
	Awards and Prizes	9,019.93
	Scholarships	
	Team Travel	3,799.37
124.00	T-shirts	5,773.67
	Supplies	577.83
712.50	Lunches	1,388.00
	Coaches gifts	
	Office Expenses	
	Copying and Postage	268.47
	Office supplies	
	Bank Charges	34.95
	Outreach	
	Workshop stipends	1,390.00
	Seed money	1,500.00
	Brochures/PR	
	Mileage	
	Travel to Nationals (State Director)	
	Other	
\$22,073.76	SUBTOTAL	\$25,352.22
	Science Bowl	
	Sponsor donations	
	School registration fees	
	Scholarships	
	Room rental fees	
	Photographers	
	Food	692.01
	Supplies	411.41
	Conference registration fees	
	Trophies and prizes	
0.37	Interest	
	Bank credits/charges	
\$0.37	SUBTOTAL	\$1,103.42
\$33,150.40	TOTAL	\$31,915.77

(Please note that the Science Olympiad is held in February or March of each year and this report is based on the calendar year. Some sponsorship dollars are received in the fall in anticipation of the upcoming year's tournament).

Karen Conzelman
Treasurer