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Climate Change and New Mexico's Water Resources

Kurt S. J. Anderson
Editor

The New Mexico Academy of Science

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The *New Mexico Journal of Science* is a publication of the New Mexico Academy of Science. Each issue of the journal, which has been published since 1960, usually contains research papers and review articles deemed of interest to the scientists, educators, and citizens of New Mexico. Some volumes have addressed topics of social or economic interest to the state while others have emphasized scientific areas in which New Mexico is particularly active. Authors have usually been drawn from the universities, colleges, and research institutions of New Mexico. Research papers are reviewed before being accepted for publication.

This year's *Journal*, subtitled "Climate Change and New Mexico's Water Resources", deviates from that tradition. This year the Annual Meeting of New Mexico Academy of Science was held Jointly with New Mexico's Experimental Program to Stimulate Competitive Research (NM EPSCoR) which is funded by the National Science Foundation. The 9 November 2013 meeting in Albuquerque NM featured over fifty oral and poster presentations by students and faculty from New Mexico's colleges and universities - and a high school. The meeting was very well attended. This volume of the *New Mexico Journal of Science* contains the abstracts of the papers and posters presented at this joint meeting of NMAS and EPSCoR.

This volume of the *Journal* is being published in an electronic-only format. This enables the Academy to provide access to the *Journal* to a much wider readership without incurring the prohibitive costs associated with the production and mailing of paper copies.

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New Mexico Journal of Science

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About the New Mexico Academy of Science

Founded in 1902, the New Mexico Academy of Science has been in continuous existence since 1915. The Academy is a member of the National Association of Academies of Science (NAAS) and an affiliate of the American Association for the Advancement of Science (AAAS). The New Mexico Academy of Science works with teachers, state agencies, and the legislature to establish appropriate standards for the teaching of the sciences. The Academy can also act as a resource center, providing scientific advice and expertise to these groups and others. The Academy Goals are to foster scientific research and scientific cooperation, increase public awareness of the role of science in human progress and human welfare, and promote science education in New Mexico. Membership is open to any person or organization engaged in or interested in scientific research, scientific education, or the goals and activities of the Academy. Visit www.nmas.org for more information about NMAS.

About New Mexico EPSCoR

New Mexico's Experimental Program to Stimulate Competitive Research (NM EPSCoR) is funded by the National Science Foundation (NSF) to build the state's capacity to conduct scientific research. Faculty and students from New Mexico universities and colleges are working to realize the state's potential for sustainable energy development, and cultivating a well-qualified Science, Technology, Engineering and Mathematics (STEM) workforce while supporting a culture of innovation and entrepreneurship. The infrastructure and activities of Energize New Mexico are designed to support shared-use equipment, engage new research and community college faculty, and support the STEM pipeline by training teachers, undergraduate and graduate students, and post-doctoral fellows. Research findings will be communicated broadly through new partnerships with New Mexico's museum network, a citizen-centric web portal, and vibrant, experiential programs targeting K-12 students. Visit www.nmepscor.org for more information about NM EPSCoR.

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Keynote Address

New Mexico's Dwindling Water Supply: Can We Solve a 21st Century Problem using 19th Century Laws?

Dr. Fred M. Phillips, *New Mexico Tech*

Abstract

Predicting changes in precipitation in the Southwestern U.S. under continuously warming climate is an uncertain proposition, but predicting change in the water balance is not. As climate warms, the water balance becomes less favorable and the renewable water supply decreases. New Mexico has fully allocated its water resources under the present climate, but as the 21st century progresses, the water supply will dwindle while the population increases. Something has to give. The laws governing water management in New Mexico were placed in the State Constitution in 1907. The principle of those laws is that water in its natural state belongs to the people of the state, but they reflect the zeitgeist of that period, which was to encourage rapid expansion of irrigated agriculture and to make sure that the rights to water withdrawal thus established would be firmly protected. As the intervening 106 years have passed, the public's perception of what they want to accomplish with New Mexico's limited supply of water has changed, but the fundamental laws have not. There is no longer any unappropriated renewable water, and thus putting water to any new use, such as growth in urban population, necessarily involves taking it away from existing users, or from the environment. Equitable reapportionment that is responsive to the interests of the 21st century public requires a system of water management that is flexible and responsive to a changing environment, but the state is operating within the straightjacket of a 19th century water code whose principal objective is to prevent change. Australia and South Africa offer examples of nations who have radically changed their water codes. New Mexico should look to them for inspiration in solving its ongoing water crisis.

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Dr. Fred M. Phillips is a Professor of Hydrology and Director of the Hydrology Program in the Department of Earth & Environmental Science at New Mexico Tech in Socorro. His undergraduate degree in Earth Science is from the University of California at Santa Cruz and he earned a Ph.D. in hydrology from the University of Arizona in 1981. His current research interests include environmental tracers in surface water and groundwater, paleoclimate and paleohydrology, surface-exposure dating using cosmogenic nuclides, tectonic geo- morphology, and the interactions of social and hydrological systems in the southwestern U.S. Dr. Phillips is co-author of Reining in the Rio Grande: People, Land, and Water.

Oral Presentations

Only the name of the presenter is given; see the abstract for the full list of authors.

Poster Presentations

Posters are listed alphabetically by last name of the presenter.. See the abstract for the full list of authors.

Oral Presentations

SESSION I Synergies of Climate Change & Invasive Species

American Bullfrog: A Self-Inflicted Amphibious Assault in the Southwest

Micah Daboub, *BioKull*
Dr. Jesús Rivas, *New Mexico Highlands University*

Abstract

Invasive species are a leading conservation for native species worldwide. The American Bullfrog (*Lithobates catesbianus*), native to eastern United States, is widely established in northern New Mexico. Most studies on invasives are limited to the eradication of the invasive but few efforts are made to understand the biology of the invasive and the nature of the invasion. In this contribution we set out to find out how an organism evolved in wet areas such as the Bullfrogs, managed to successfully colonize semi-arid habitats in northern New Mexico, including displacing the native Leopard frog (*L pipiens*) from its natural habitat. We implanted 4 bullfrogs with temperature sensitive radio telemetry equipment to identify home range and habitat selection of Bullfrogs in the Mora River. We found that adult bullfrogs were preferentially selecting habitats containing thick secondary vegetation that resulted from human degradation of riparian forest canopy as well as artificial ponds. Most of the diet found in 560 Bullfrogs consists of the invasive Northern crayfish (*Orconectes virilis*). It is not possible to know if Bullfrogs would have been able to colonize Northern New Mexico if the original conditions were in place but it seems likely that, at least, a lot of the success they have had is thanks to anthropic habitat modifications. There are many reasons why we should restore the original habitat in NM, it seems that preventing invasions of exotic species is another reason to add to the list.

keywords

Bullfrogs, invasive species, biodiversity, telemetry, management

The Response of the Native Aquatic Fauna to the Eradication of Bullfrog in a Section of the Mora River

Adrian Carter, *New Mexico Highlands University*
Micah Daboub, *BioKull*
Robert Ortega, *New Mexico Highlands University*
Dr. Jesús Rivas, *New Mexico Highlands University*
Justin T. Saiz, *New Mexico Highlands University*
Steven Salinas, *New Mexico Highlands University*

Abstract

This paper summarizes the body of research on the vertebrate community of the Mora River being carried out by faculty and students of New Mexico Highlands University. This paper is an anchor to the context in which many of the projects that are taking place, with reference to the general methods used in a common study site and the various techniques that were applied. The core of the project consists on evaluating the impact of Bullfrogs (*Lithobates catesbeiana*) eradication in the community of aquatic vertebrates. For this purpose, a section of the Mora River was divided in two regions. The first region was the experimental area where the bullfrogs were eradicated using different methods and another half, a control region, where bullfrog populations were not affected. Most of the project associated in this site look at the impact of the presence or absence of bullfrogs on different aspects of the ecosystem.

keywords

Bullfrogs, invasive species, biodiversity, aquatic fauna

Leopard Frog Population Structure in Dynamic Environmental Conditions

Dr. Sarah Corey–Rivas, *New Mexico Highlands University* Dr. Jesús Rivas, *New Mexico Highlands University*
José Griego, *New Mexico Highlands University*

Abstract

Riparian areas in Northern New Mexico have suffered significant environmental degradation due to over-grazing and deforestation. This habitat fragmentation is expected to create genetic barriers for various representatives of wildlife. Leopard frog populations (*Lithobates pipiens* & *Lithobates blairi*) that inhabit New Mexico persist in these habitats that have been affected by disturbances as well as fires and drought. Habitat fragmentation may create conditions of inbreeding by limiting dispersal and may also increase the chances of hybridization between sister taxa due to congregation of once separate populations. This study will investigate leopard frog gene flow between populations and hybridization among *L. pipiens* and *L. blairi* using microsatellites, single copy nuclear genes, and mitochondrial genes in the upper Mora River. The study will compare structure of populations in relation to the type of habitat that samples are taken from (fragmented or healthy). Combined, these will provide data regarding genetic and behavior patterns in habitats subject to frequent change due to various levels of disturbance.

keywords

Leopard frog, population, genetics

Detection of Chytrid Fungus and Population Monitoring of the Northern Leopard Frog in Northern New Mexico

Lisa McBride, *New Mexico Highlands University*
Dr. Sarah Corey–Rivas, *New Mexico Highlands University*

Abstract

The invasive American bullfrog (*Lithobates catesbeianus*) has negatively impacted native amphibian populations of New Mexico including Northern Leopard Frog (*Lithobates pipiens*). At the Rio Mora Wildlife Refuge along the Mora River, bullfrogs are abundant and compete with native frogs for habitat and food, and can act as vectors of the harmful chytrid fungus, *Batrachochytrium dendrobatidis* (Bd). To determine the impacts of bullfrogs on native fauna, we set up an experimental section of the Mora River where bullfrogs were eradicated and a control section of the river where bullfrogs continue to persist. We measured the abundance of leopard frogs at both sites to determine if leopard frogs will recover in numbers along the Mora River. We monitored native and invasive amphibians for Bd presence in the experimental and control sites and at connected sites in the Mora Watershed. Ventral surfaces of each amphibian were swabbed and samples were tested for Bd presence using a PCR screening procedure with Bd-specific primers (Bd1a, Bd2a) to amplify a 300 bp fragment of Bd DNA. Analysis of PCR products through gel electrophoresis indicate that Bd is present in certain areas of the Mora Watershed but so far, no Bd has been detected at Rio Mora Wildlife Refuge (n=20). The PCR-based Bd detection method provides a useful tool to better understand the potential threat this disease poses for the endangered leopard frog population. Future work will involve sampling leopard frogs in the focal area and surrounding watershed to monitor leopard frog recovery in the following years.

keywords

Bullfrogs, fungus, leopard frogs, population

Geomorphic Effects of a High Severity Burn in the Las Conchas Fire

Dr. Sara Brown, *New Mexico Highlands University*
Anita Lavadie, *New Mexico Highlands University*
Dr. Edward Martinez, *New Mexico Highlands University*
Richard McNeill, *Luna Community College*
Joe Zebrowski, *New Mexico Highlands University*

Abstract

High fuel loads and extremely dry conditions have led to previously unknown fire behavior and effects. This study investigated the effect runoff from burned areas had on erosion and arroyo formation in the Cerro del Medio drainage within the Valles Caldera National Preserve, which was burned in the Las Conchas Fire in 2011. This drainage is 139 hectares and 2.3 km long. The majority of the drainage was categorized as a moderate or low severity fire. 24 hectares of the drainage were categorized as a high severity fire. The first post-fire monsoon season was slightly above average with 129.79 mm of precipitation in September and October. The first monsoon season's runoff from the high severity patch has resulted in rapid geomorphic change. An arroyo has formed that ranges up to 9.8 m wide and to 2.45 m deep. Upon leaving the constrained drainage it has resulted in an alluvial fan deposit that is 24 hectares in two lobes with the longest lobe 1.9 km long. Changing fire behavior has resulted in larger and more severe fires and this will likely result in rapid and extreme geomorphic changes on a landscape scale with a corresponding impact on human activities.

keywords

Fire, geomorphology, Los Conchas

Hydrologic Impacts of Burn Severity on Nutrient Concentrations from Surface Water Runoff and Soils after the Las Conchas Fire

Dr. Sara Brown, *New Mexico Highlands University*
Dr. Gil Gallegos, *New Mexico Highlands University*
Anita Lavadie, *New Mexico Highlands University*
Dr. Edward Martinez, *New Mexico Highlands University*
Joe Zebrowski, *New Mexico Highlands University*

Abstract

Climate change is currently exhibiting intensified wildfire behavior and severity conditions in the Southwest. Following large fires, or mega-fires, surface water runoff and soils contribute high concentrations of nutrients to water bodies and has the potential to impair surface water quality in urban and rural environments. Although there is a considerable amount of research on the effects of nutrients in surface water runoff and soils following a fire, the need to investigate mega-fire conditions on nutrient levels transported from various fire severity classes is less understood. The purpose of this study is to investigate the contributions of, nitrate–nitrogen (NO_3–N) and orthophosphate (OP) levels in surface water runoff and soils originating from various wildfire severity classes from the Las Conchas fire in the Jemez Mountains, New Mexico. To complete this task, NO3–N and OP concentrations will be determined from surface water runoff and soils originating from qualified high, moderate, low, mixed, and control (unburned site) fire severity types. Fire severity site qualification was determined using geospatial applications and a simple linear regression model in a previous study.

keywords

Storm water, soils, severity, Las Conchas, nutrients

Resistance and Resilience of Diatom Taxa to Impacts of Forest Fire

Dr. Rebecca Bixby, *University of New Mexico*
Dr. Clifford Dahm, *University of New Mexico*
Alexander Clark, *University of New Mexico*
Betsy Shafer, *University of New Mexico*

Abstract

Diatoms are used to monitor changes in environmental conditions on both local and regional scales. The Las Conchas wildfire, which started in June 2011, burned the headwaters of the East Fork Jemez River, a high-elevation mountain stream in the Valles Caldera, New Mexico. The purpose of the study was to understand how epiphytic diatom communities on the macrophyte *Elodea canadensis* changed throughout the growing season due to seasonal and fire impacts. Elodea and its diatom epiphytes were periodically collected from three pools along the East Fork from March-October 2011 as well as June and July of 2012. To date, 100 diatom taxa have been found in the system. In the pre-fire months, diatom diversity increased as *Elodea* density increased. This increase included *Epithemia* spp., which contain endosymbiotic cyanobacteria and are characteristic of nitrogen-limited systems. However post-fire, *Elodea* was substantially reduced in biomass and the diatom community became dominated by prostrate growth forms that remained or recolonized post-fire. Several months post-fire, the diatom communities returned to near baseline density and no significant difference in mean density was observed ($P=0.869$); this is contrasted with mean species richness, which decreased significantly post-fire ($P=0.013$). With continued research into diatom assemblage changes, it may be possible to use them as an indicator for long-term climatic changes (warming, reduced precipitation, and earlier snowmelt) that are projected for mountain streams.

keywords

Macrophyte, diatom, epiphyte, Valles Caldera, fire

The Effects of Forest Fire on Submerged Aquatic Macrophyte Biomass and Production in a Mountain Stream

Dr. Clifford Dahm, *University of New Mexico*
Betsy M. Shafer, *University of New Mexico*
Dr. Rebecca Bixby, *University of New Mexico*
Virginia F. Thompson, *University of New Mexico*

Abstract

Surface water systems are increasingly critical for human water supply sources in the Southwest as decades of groundwater aquifer depletions limit groundwater resources. High elevation 'critical zone' headwater areas, such as the East Fork Jemez River (EFJR) in northern New Mexico, are key components of these surface water systems. Submerged Aquatic Macrophytes (SAMs) can be critical species when present in a system by providing ecosystem services such as water quality mediation, habitat structure, and food production. The EFJR in the Valles Caldera National Preserve is a low gradient grassland stream with high productivity driven throughout the growing season by three SAM species: *Elodea canadensis*, *Ranunculus aquatilis*, and *Potamogeton richardsonii*. The Las Conchas fire burned over 157,000 acres of forest and grassland in June and July of 2011 with over 50% burned moderately or severely. Post-fire precipitation events caused significant flooding and water quality changes such as increased sediment loads and nutrient concentrations. Water column biomass was collected and measured using a standard ash-free dry weight procedure. Primary production estimates were made using daily variations in dissolved oxygen concentrations with a modeling routine. SAM biomass peaked at 12,235 g/m^2 and the production rate peaked at 15.2 g O_2/m^2/day just before the post-fire precipitation events. Pre– and post-fire assessment and monitoring of the onsite SAM species show a significant ($p < 0.01$) decrease in SAM biomass present the fall after the fire. Fire-related impacts have negatively impacted SAM biomass and productivity.

keywords

Biomass, primary production, aquatic macrophytes, fire effects, aquatic ecosystems

Use of Continuous Sensors to Monitor Water Quality and Nutrient Dynamics in Streams in Forested Catchments Undergoing Global Change: The Jemez River System in Northern New Mexico

Dr. Laura Crossey, *University of New Mexico*
Dr. Clifford Dahm, *University of New Mexico*
Lauren Sherson, *University of New Mexico*
David van Horn, *University of New Mexico*
Betsy Shafer, *University of New Mexico*

Abstract

Global change is impacting the forests of the western United States in ways other than simply warming temperatures. Earlier snowmelt, more rain and less snow, greater vapor pressure deficits in spring and fall, forest dieback, and catastrophic forest fires are fundamentally changing the character of forested catchments throughout the western United States. Our interdisciplinary research team has deployed continuous measuring in situ sensors for temperature, conductivity, pH, turbidity, dissolved oxygen, nitrate, and phosphate throughout the year to study ecosystem production and respiration and nutrient dynamics in a high elevation mountain stream in New Mexico experiencing global change (East Fork Jemez River and Jemez River). Multi-year deployment has allowed us to measure ecosystem production, ecosystem respiration, and nutrient availability and uptake under 1) variable spring snowmelt conditions; 2) strong and weak summer monsoon precipitation; and 3) before and after a major catastrophic fire in the catchment. Strong snowmelt and monsoon conditions reduce primary production and ecosystem respiration rates. Weak snowmelt conditions and weak or delayed summer monsoons produce higher rates of primary production and ecosystem respiration by well-developed biofilms, filamentous green macroalgae and aquatic macrophytes within the stream. Strong diurnal fluctuations in nitrate and phosphate accompany high rates of primary production and ecosystem respiration. Catastrophic fire in the catchment in late June and early July of 2011 has dramatically altered both nutrient concentrations and ecosystem processes after precipitation events. Phosphate and nitrate increases, turbidity peaks, dissolved oxygen and pH sags, conductivity increases, and increased detrital organic matter inputs have all been byproducts of the major fire that burned most of the forested headwaters of this mountain valley stream. Downstream monitoring coupled with traditional campaign water sampling and geochemical analysis show that decreases in runoff result in water quality deterioration through relative increases in input of saline, metal-rich geothermal groundwaters. Dramatic changes in catchment characteristics are very likely to be the strongest impacts of global change on the streams and rivers of the western United States.

keywords

Geothermal, Jemez River, nutrient dynamics, in situ

Utility of Stream Temperature and Hydrology Monitoring: Implications of Climate Related Vulnerabilities and Persistence of Rio Grande Cutthroat Trout

Dr. Colleen A. Caldwell, *U.S. Geological Survey & New Mexico State University*
Andrew S. Todd, *U.S. Geological Survey*
Matthew P. Zeigler, *New Mexico State University*

Abstract

The Rio Grande cutthroat trout, the southernmost subspecies of cutthroat trout, occupies approximately 12% of its historical range throughout New Mexico and Colorado and has recently been added as a candidate species for protection under the Endangered Species Act. Several risks threaten the subspecies' persistence including nonnative salmonids, population isolation caused by habitat fragmentation, and climate change. A stream temperature and

summer baseflow research and monitoring program was initiated in 2010 to increase our understanding of the subspecies' climate vulnerabilities. To date, more than 60,000 days of stream temperature and over 200 baseflow measurements have been collected from 125 monitoring sites. Our monitoring has revealed 87% of populations experienced stream temperatures below the subspecies' laboratory-derived thresholds, with a smaller subset of streams (13%) approaching sub-optimal and lethal thermal conditions. Fall baseflow measurements revealed 67% of the populations experienced discharge levels less than 1.0 cubic feet/second, with three sites dry, identifying a potential climate-related risk to many of the populations. The episodic nature of intermittency in streams makes documentation of timing of dry events difficult. We developed and deployed a sensor to measure intermittency and monitoring is currently ongoing to better understand stream drying frequency. Data collected from the monitoring program is used to develop decision tools to inform future management of these conservation populations by factoring in climate-related effects including both increasing stream temperature and altered hydrological regimes. We highlight how a changing climate affects native fishes in New Mexico and the development of management strategies to protect aquatic species of concern.

keywords

Climate change, Rio Grande cutthroat trout, monitoring, stream temperature

The Potential Impact of Climate Warming on Snowmelt Runoff in the Upper Rio Grande Basin

Emile Elias, *New Mexico State University*
Dr. John Mejia, *Desert Research Institute*
Dr. Albert Rango, *New Mexico State University*
Dr. Caitriana Steele, *New Mexico State University*

Abstract

We have used the Snowmelt Runoff Model (SRM) to simulate runoff from melting snowpack in high elevation sub-basins in the Upper Rio Grande (URG). SRM was parameterized using historical snow cover, climate and streamflow data for dry, moderate and wet years. The derived parameters were then used in simulations of runoff under warmer climate conditions. Sixty climate models included in the Coupled Model Intercomparison Projects CMIP–3 and CMIP–5, were assessed to determine which models best represented (i) the general trend in warming and (ii) variability around the general trend (wetter/warmer, dryer/warmer, wetter/hotter, dryer/hotter). Here we present results of groups of simulations for 25 sub-basins for two years: 2049 and 2099. When climate warming is coupled with dryer conditions, we see loss of snowpack at all but the highest elevations. With declining snowpack, there is also a decline in springtime streamflow (fraction of flow occurring between April and July) and earlier occurrence of winter-spring center of volume (half total runoff volume for January 1 to May 31). The impact of climate warming on springtime streamflow is less pronounced under warmer, wetter conditions. Indeed, under wetter conditions we may see overall increased mean annual flow and increased springtime streamflow. Changes in the quantity and timing of flow is of particular interest to those communities who depend on snowpack acting as a natural reservoir. We conclude this presentation with a closer examination of how snowmelt runoff under a changing climate may affect the acequia community of El Rito.

keywords

Climate warming, snowmelt, runoff

Diel Fluctuations of Arsenic Concentrations and Physiochemical Parameters along the Jemez River

Lorraine Garcia, *New Mexico Highlands University*
Edward A. Martinez, *New Mexico Highlands University*
Daryl Williams, *New Mexico Highlands University*

Abstract

Several studies have shown that the hydrothermal springs in the Jemez Mountain region contribute high concentrations of arsenic to the Jemez River. The shorter and warmer winters have resulted in less snowpack and spring runoff thereby increasing the hydrothermal spring contribution of water and solutes to the Jemez River. A 72hr–study was conducted in June 2012 and 2013 to determine how total and dissolved arsenic concentrations fluctuate diurnally, and also to determine what physiochemical and site parameters dictate the fluctuations. This study demonstrates that the arsenic concentrations fluctuated up to 60% between night and day, and that a variety of physiochemical parameters, including temperature, dissolved oxygen, pH, conductivity, and stream discharge are closely correlated to the diurnal fluctuation in arsenic. These findings provide insight to long term changes that the river may experience in the future due to climate change impacts. As the regional climate changes with a continual increase in temperature and decreased snow pack, it is highly probable that arsenic concentrations will rise in the river; possibly high enough to impact downstream users and the water quality of the Rio Grande River.

keywords

Arsenic, climate change, diurnal, temperature, discharge

SESSION IV Southwestern Wildlife Ecology

Bison Conservation Genetics Study at the Rio Mora National Wildlife Refuge, New Mexico

Dr. Sarah Corey–Rivas, *New Mexico Highlands University*
Lisa McBride, *New Mexico Highlands University*
Wacey Cochis, *New Mexico Highlands University*
Dr. Brian Miller, *Wind River Ranch*
Dr. Jesús Rivas, *New Mexico Highlands University*

Abstract

Bison (*Bison bison*) presently face a variety of threats to their long-term survival as a species, including the spread of new diseases, low genetic diversity, and the introgression of domestic cattle genes. At the Rio Mora National Wildlife Refuge in New Mexico, we are conducting a study of the genetic diversity and cattle hybrid status of the resident wild bison herd in order to ensure its conservation significance. Here, we report on the cattle hybrid status of bison using a mitochondrial genetic marker, the D–loop. We have identified three WRR bison as cattle hybrids using this method. We also report the presence of two distinct bison mitochondrial lineages found at the refuge, one lineage unique to the refuge and unreported in the literature, and one shared by bison at Yellowstone, the National Bison Range, the Texas State Bison Herd, and the Fort Niobrara NWR. Refuge bison are an important resource for national efforts to conserve the genetic integrity and future genetic diversity of the species. Therefore, we propose to continue a survey of genetic diversity of all bison at the refuge using the D–loop sequencing and a microsatellite analyses. We request additional DNA sampling to determine the extent of the unique lineage and to further characterize the extent of cattle introgression in the herd.

keywords

Bison, conservation, molecular ecology, hybridization

Characterization and Analysis of Urban Black Bear Populations in Northern New Mexico

Dr. Sarah Corey–Rivas, *New Mexico Highlands University*
Dr. Jesús Rivas, *New Mexico Highlands University*
Casey Taylor, *New Mexico Highlands University*

Abstract

Conflicts between humans and Black bears (Ursus americanus) have increased in the recent decades, with little change in sight. These conflicts have arisen due to habitat degradation, human expansion into Black bear habitat, and anthropogenic attractions in urban areas. Urban bears are rather common in New Mexico where bears are often seen in town and around dumpsters. Conventional wisdom states that once a bear has come to town they do not leave. These bears stop being a participant of the rural ecosystem and become urban animals. The purpose of this study is to assess the magnitude of the urban bear problem by determining the abundance, and movements of these urban populations, in comparison with rural populations. Transects were randomly assigned within the city limits and in the neighboring areas to determine relative abundance of Black bears by counting scat and bear sign. Scat and hair samples were collected to determine individuals through the use of microsatellite analysis, as well as tracking movement patterns. Telemetry was used to track the movements of two sows (one with two cubs) through the Summer and Fall of 2013. I found more scat in town than in the neighboring areas (t=2.98, df=13, p=.005, one tail). Both sows were collared in town but moved to rural areas in the fall, presumably seeking hibernation dens.

keywords

Black bears, telemetry, genetics

The Role of Wintering Frugivores in the Dispersal Ecology of One-seed Juniper in Northeastern New Mexico Rangelands

Will Jaremko–Wright, *New Mexico Highlands University*

Abstract

The encroachment of junipers into rangelands is dependent upon; the types of animal dispersers present and their post-foraging behavior, micro-site requirements for successful seed germination, and the availability of structurally complex perches. The role of birds in the dispersal ecology of One-seed juniper (*Juniperus monosperm*a) in northeastern New Mexico was investigated along a continuum of juniper establishment from young savannas to old-growth woodlands. The wintering bird community was sampled with variable distance point counts (VPC) from January to March, 2013. Stand establishment date, juniper regeneration, canopy cover, and other habitat variables were also measured at points. Not surprisingly, frugivorous thrushes (*Turdidae*) were the most commonly encountered group of birds and showed significant habitat partitioning based on tree canopy cover and vegetation complexity. Mountain bluebirds (*Sialia currucoides*) were the most abundant species in the study area, and were found at their highest densities in savannas with the lowest canopy cover. This is significant because these savannas are the youngest in age, and are effectively the ecotone between the juniper woodland and grassland (i.e., where the most active encroachment is occurring). Results showed that a significant proportion of seedlings were found under structurally complex perches; female trees (59%), male trees (29%), and shrubs (5%), highlighting the importance of perches and seedling emergence. Although other species known to consume and disperse juniper seeds were present, the abundance, behavior, and habitat preference of mountain bluebirds suggest they are the primary avian disperser of juniper into grasslands of northeastern New Mexico.

keywords

Encroachment, *Juniperus monosperma*, *Sialia currucoides*, seed dispersal, biological inertia, mutualism, frugivory

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Dietary Preferences of Urban Texas Horned Lizards in the Absence of Preferred Prey

Shantini Ramakrishnan, *New Mexico Highlands University & Southern Illinois University*

Abstract

Texas horned lizards (*Phrynosoma cornutum*) are ant specialists that are experiencing steady declines, in part due to habitat loss and ant pest control programs. Dietary specialization makes their populations intimately linked to the health and abundance of their ant prey. Urban *P. cornutum* populations may persist in isolated habitat patches bereft of their chief ant prey, harvester ants (*Pogonomyrmex* spp.), presumably because they are foraging on alternative ant taxa. We studied ant availability and use by *P. cornutum* on an urban wildlife reserve in central Oklahoma to examine this question. The 5 most commonly available ant genera based on captures at 168 bait stations were: *Monomorium* (69%), *Forelius* (11%), *Pheidole* (10%), *Crematogaster* (7%), and *Tapinoma* (2%). Based on the examination of 124 scat samples from adult and juvenile *P. cornutum*, *Crematogaster* (81%), *Pheidole* (12%), Formica (6%) and *Monomorium* (1%) were used as lizard prey. *P. cornutum* consumed select ant genera disproportionately to their availability. Factors affecting this variability may be related to ant biomass and corresponding nutritional value. Among juveniles, gape size did not appear to influence prey use of Pheidole, but may influence use of Formica.

keywords

Phrynosoma cornutum, Texas Horned Lizard, urban wildlife, diet selection

SESSION V Energy & Sustainability

Influence of ZnS Crystal Structure and Surface Area on the Photochemical Reduction of Aqueous Bicarbonate to Formic Acid

Daniel P. Leonard, *New Mexico Tech*

Abstract

There has been much investigation into the use of various semiconductors, TiO_2, MnS, ZnS, and CdS, to reduce CO_2 into economically viable products. Of particular interest is zinc sulfide due to its low cost, low toxicity, wide band gap and proven ability to photo-reduce CO_2 to formic acid. In the years of investigation using ZnS, there have been no studies that examine the influence of crystal form on catalytic productivity. ZnS occurs in two possible crystal forms, wurtzite and sphalerite. Herein we report on the effects of crystal structure on the reduction of HCO_{3-} and the attempted use of organic dye photosensitizers on the rate of production of formate. In addition we examine the reaction conditions in order to identify the most likely substrate for photo-reduction.

keywords

Photo-reduction, zinc sulfide, bicarbonate, nanoparticles

Algal Turf Scrubber for Treating Dairy Manure Effluents and Producing Sustainable Biofuel

Dr. Juchao Yan, *New Mexico Tech*

Abstract

New Mexico has more than 250,000 dairy cows, and is the ninth largest milk producing state in the US. Although the dairy industry in New Mexico is the biggest agricultural activity in the state with the greatest economic impact, it is facing the greatest environmental challenge of managing dairy manure effluents. On a single day, 5.6 million gallons of manure, an amount enough to fill nearly nine Olympic-sized pools daily, are generated in the industrialized dairies in New Mexico. The dairy manure waste leads to odor emission, flies propagation, and potential contamination of water above and below ground. Since 2012, for example, only 18 out of 128 dairy discharge permits have been issued in New Mexico. Cultivating algae on nitrogen and phosphorus in dairy manure effluents is an alternative to the current practice of land application, and has real potential in utilizing the high nutrient resources for cost-effective biofuel production. In this talk, we will summarize the literature work about recovering nitrogen and phosphorus from dairy manure effluents on an outdoor Algal Turf Scrubber for the dual purposes of wastewater treatment and

sustainable algal biofuel production. Algal Turf Scrubber is an engineered system, which flows pulsed wastewater over slopping surfaces with attached and naturally seeded filamentous algae. For removing nutrient waste, Algal Turf Scrubber has been applied to surface water runoff, agricultural and municipal effluents.

keywords

Diary manure effluents, algae, biofuel

Ecosystem Services of Acequias in the Historic Rio Arriba Region

Dr. Bill Flemming, *University of New Mexico*
Amy Miller, *University of New Mexic*o
Matt Piccarello, *University of New Mexico*
Dr. José Rivera, *University of New Mexico*

Abstract

Ecosystem services provided by community irrigation systems known as *acequias* include extending the area of green space between *acequias* and streams, a *paisaje del agua* or water landscape. Most of the early earthen canals were built by hand dating to the colonial period of Spanish–Mexican settlement of the Rio Arriba, a historic district of the upper Rio Grande of New Mexico and southern Colorado. After more than four centuries of continuous use, the traditional gravity flow irrigation methods of these systems remain intact and notably, they enhance vegetative cover and diversity within the *paisaje*, support wildlife habitat, recharge shallow aquifers, sequester carbon, improve air and water quality, retain storm-water flow, and control flooding. They also provide nutrient cycling and soil formation, ecotourism and environmental education, extension of the irrigation season, and aesthetic enrichment in ecological landscape diversity. As part of a National Science Foundation study, researchers at the University of New Mexico developed a rating system for evaluating the relative extent of ecosystem services provided by *acequias* through a combination of GIS and field methods to determine riparian health. The rating system evaluated sixteen ecosystem services on a scale from poor to excellent. Results from two *acequias* on the Rio Hondo in Taos County indicate that the ecosystem services provided by these traditional irrigation systems are substantial. The evaluation data provide scientific support for the protection of the *paisaje del agua* as an important cultural and ecosystem landscape of value to the broader society, including benefits of rural development, cultural tourism, enhancement of environmental amenities, and local food security of small scale agriculture.

keywords

Ecosystem services, riparian health indicators, cultural landscapes

Energy Efficiency & Renewable Energy Benefits–Agua Caliente Band of Cahuilla Indians Implementation

Chelsea Chee, *University of New Mexico*

Abstract

Global warming is a result of the increasing energy demand and greenhouse gas emissions; now it is effecting society through the changing climate in the form of natural disasters. Simultaneously, historically used energy resources are being depleted and over-extended infrastructure is costly to meet the increasing demand. Energy efficiency and renewable energy installations can be solutions to these challenges by reducing demand, generating energy on-site, emitting little or no greenhouse gases, and decreasing life-cycle costs; as the Agua Caliente Band of Cahuilla Indians demonstrate with their historical Indian Canyons Trading Post. The Trading Post is located within tribal boundaries and 2 miles from the electric grid. Propane was used for several years to run the off-grid site until costs became too high. With a Federal grant, an 8.25 kilowatt photovoltaic array became the new source of energy in 2009. This resulted in an energy demand, cost, and carbon dioxide emissions savings; which proved to be more cost effective than running business as usual. The tribe is slowing down and reducing the effects of climate change at a local and global level.

keywords

Energy efficiency, renewable energy, tribal

The Impacts of a High Severity Wildfire on Population Dynamics of Amphibians in Northern New Mexico and Southern Colorado

Dr. Sara Brown, *New Mexico Highlands University*
Dr. Sarah Corey–Rivas, *New Mexico Highlands University*
Justin T. Saiz, *New Mexico Highlands University*
Dr. Jesús Rivas, *New Mexico Highlands University*
Steven Salinas, *New Mexico Highlands University*
Molly Wright, *New Mexico Highlands University*

Abstract

Climate models are predicting that the planet will become hotter and drier. As a result, natural disturbance cycles, such as forest fires, have been altered across many ecosystems, including amphibian habitat. The North American landscape provides a prime example of these changes with its fire prone ecosystems, especially in the Southwest. Fire suppression throughout this area during the last century has drastically altered the fuel loading in some forest types, thus changing severity and frequency of forest fires. This increase in fuels has contributed to high severity mega forest fires burning massive plots of land, potentially causing drastic changes to amphibian populations. One such mega forest fire was the Track fire, which burned 11,247 ha in 2011 on the boarder of New Mexico (NM) and Colorado (CO). Therefore, it is important to understand how these mega forest fires with high severity impact native amphibian populations. The purpose of this study is to understand the impacts of the Track Fire on amphibian population dynamics within northeastern NM and southern CO. We pose the following question: How did the Track Fire impact amphibian population dynamics, vegetation, and water quality? The null hypothesis for this proposal is that amphibians, vegetation, and water quality will not be impacted by the high severity of the Track fire between the area burned and a control area that has not recently experience forest fire. Data will be collected by conducting visual and frog call transects surveys as well as a massive capture effort will be made during the summer to understand amphibian populations and their dynamics. Additionally, experimental (area burned) and control (area unburned) line-point intercept transects will measure the changes in vegetation, and experimental (area burned) and control (area unburned) analysis of water nutrients will be conducted in all three site locations. The goal of this study is to provide further understanding of how high severity fire impacts amphibians and their habitat.

keywords

Photo-reduction, zinc sulfide, bicarbonate, nanoparticles

Short-term Effects of the Las Conchas Fire on Stream Benthos

Dr. Rebecca Bixby, *University of New Mexico*
Alexander Clark, *University of New Mexico*
Dr. Clifford Dahm, *University of New Mexico*
Anna T. Hamilton, *University of New Mexico*
Dr. Gerald Z. Jacobi, *New Mexico Highlands University*
Betsy M. Shafer, *University of New Mexico*
Lauren Sherson, *University of New Mexico*
Shann Stringer, *TetraTech*
Virginia Thompson, *University of New Mexico*

Abstract

The East Fork Jemez River is a high-elevation, low-gradient headwater stream in the Valles Caldera of New Mexico. The study site is instrumented for continuous measurements of a variety of water quality, water chemistry, and surface and groundwater data with the long-term goal of studying climate variability and climate change impacts on water quantity and quality. Biological processes and communities, including benthic macroinvertebrates, have been sampled periodically since March 2011. In June and July of 2011 the Las Conchas wildfire burned headwaters of the study area, providing an opportunity to examine short-term impacts of extreme fire in the watershed on water quality,

stream chemistry, and biological responses. The benthic community was compared at riffle and pool sites during 5 collection periods from March to October. Results link severe fire impacts in the upper forested watershed to downstream water quality through pulsed monsoonal flow events affecting turbidity, DO, pH, and nutrients. Minimal benthic invertebrate responses were found in total abundance or taxa richness. However, numerous taxa responded to post-fire flow and water quality disturbances either positively, negatively, negatively with recovery, or neutrally, with responses captured by selected habitat and feeding type traits.

keywords

wildfire disturbance, stream macroinvertebrates, climate change, short-term fire effects

Antimicrobial Properties of Medicinal Plants of the Southwest

Theresa Garcia, *Northern New Mexico College*

Abstract

Medicinal plants have been used by indigenous cultures since prehistoric times to current day. *Mahonia fremontii, Artemisia Vulgaris, Gutierrezia sarothrae, Sphaeralcea Ambigua,* and *Allium sativum* have all been historically used to treat ailments linked to microbial infection. The chemical compounds of these plants were extracted using a Soxhlet technique. The solvents used were hexane for nonpolar compounds, ethanol for polar compounds, and acetone for polar and nonpolar compounds. Extraction solvents were removed by distillation. The compounds were then tested for their effect on gram positive bacteria (*bacillus subtilis*). Microbial inoculated diffusion plates of Muller–Hinton agar were created. The compounds were then loaded into wells and inhibition zones were measured after 24 hours of incubation.

keywords

Antimicrobial, medicinal plants, indigenous, biology

Evaluating the Impact of the Invasive Bullfrog (*Lithobates catesbeianus*) in the Aquatic Fauna's Trophic Cascade at the New Mexico Rio Mora National Wildlife Refuge

Jennie Guilez, *New Mexico Highlands University*

Abstract

Invasive species are known to cause devastating effects in habitats they do not naturally occur in. Invasive species can be introduced on purpose or by accident most commonly by human activity. They are known to increase competition for habitat and food resources with native species. Invasive bullfrogs (*Lithobates catesbeianus*) have been introduced along the Mora River at the Rio Mora Wildlife Refuge in northeastern New Mexico. In an effort to understand the impact of bullfrogs in the aquatic fauna we eradicated the bullfrogs in a 2 km section of the Rio Mora while leaving a comparable section intact. With their removal it was determined that an important component of the diet of bullfrogs turned out to be the invasive northern Crayfish (*Orconectes virilis*). In this study we hypothesize that the removal of bullfrogs in the Mora River will release the crayfish populations which may irrupt to a mesopredator release. To determine this we sampled the relative abundance and overall size of Crayfish in both sites using minnow traps in 12 hour periods for 3 days of sampling.

keywords

Invasive species, bullfrogs, Mora river, crayfish, aquatic fauna

Poster Abstracts

Economics of Drought in the Middle Rio Grande: A System Dynamics Modeling Approach

Dadhi Adhikari, *University of New Mexico*
Vincent Tidwell, *Sandia National Laboratory*
Dr. Janie Chermak, *University of New Mexico*

Abstract

The timing and severity of drought may severely impact water availability, especially in semi-arid climates like the American Southwest. We develop a dynamic optimization model to show an adverse impact of drought on aquifer volume. We further construct a System Dynamics model that simultaneously considers the physical hydrology in the Middle Rio Grande, the engineered water management system (Roach 2008), and a behavioral model of residential water demand, we consider the residential water use for the cities of Albuquerque, Rio Rancho and Santa Fe, New Mexico over a 50 year time horizon. We find that droughts that occur in later periods when we have larger populations have larger impacts and the duration of the drought is important. This impacts not only human consumption, but also the aquifer level. While alternative policies can provide some relief, the type of policy, the severity of that policy, and the timing of drought are important—as may be the form of economic growth in an area. We estimate economic impacts of the alternative scenarios. Given some of the forecasts of severe and multiple drought in the SW in the coming years, management tools that consider a longer-term time horizon may provide adequate time to develop more robust policies.

keywords

Drought, water, system Dynamics model

Examining the Effects of Seasonality and Frequency of Prescribed Fire on Black-Tailed Prairie Dog (*Cynomys ludovicianus*) Colony Expansion

Felicia Archuleta, *New Mexico Highlands University*

Abstract

Black-tailed prairie dogs (*Cynomys ludovicianus*) are considered to be a keystone species in grassland ecosystems. In addition to serving as prey for the endangered Black-footed ferret (*Mustela nigripes*), prairie dogs conspicuously alter landscapes and provide foraging, shelter, and nesting habitat for a diverse array of grassland species. Both the presence of prairie dogs and fire are important to maintaining the integrity of and species diversity in grassland ecosystems. Anglo-European settlement of the grasslands during the late 19th century has had a long lasting effect on the ecological structure of the Great Plains. Fragmentation and widespread grazing and cultivation affected not only the natural fire process in which grasslands evolved, but also prairie dog colonization. Due to a number of factors, fragmentation and habitat loss included, the lands currently occupied by prairie dog colonies are thought to represent less than 10% of their historical range. The occurrence of fire in grassland ecosystems plays a vital role in maintaining the integrity of grasslands by influencing the rate of nutrient turnover, regulating plant communities, reducing woody species, and discouraging invasion of non-native species. The goal of this study is to examine how seasonality and frequency of prescribed fire, during periods of extreme drought, may be used as a potential management tool for encouraging prairie dog colony expansion in shortgrass steppe. Knowledge of how prescribed fire affects prairie dog colonization is vital for developing and implementing science-based land management strategies.

keywords

Bullfrogs, invasive species, biodiversity, aquatic fauna

Economics of Drought in the Middle Rio Grande: A System Dynamics Modeling Approach

Brandon Bridge, *University of New Mexico* Dr. Janie Chermak, *University of New Mexico*

Abstract

Many areas around the world are experiencing increased stress on their water resources. Much of this stress is concentrated in arid and semi-arid regions, which are particularly ill-suited to deal with this difficulty. In both the developing and the developed world alike; shortages and poor water quality, along with growing populations and increased demand for agricultural production, create areas susceptible to water-related crises. Much of this crisis stems from the depletion of aquifers in water stressed areas. Many of these aquifers are being depleted due to mismanagement and common-pool resource problems. This paper provides a theoretical framework for the optimal management of a transboundary aquifer. This framework observes the problem as a dynamic game of two agents while allowing for asymmetry in benefit and cost functions of groundwater use. We find that groundwater savings will likely result from a cooperative scenario. A case study is examined in the Middle Rio Grande basin in north-central New Mexico. Systems dynamics modeling is used to simulate coordinated management of aquifer pumping between two cities. It is found that coordinated price increase between the cities of Rio Rancho and Albuquerque can conserve between 600,000–1 million acre-feet of groundwater over the next 30 years. It is also found that coordinated strategies can reduce aquifer draw-down by over 70 feet in some areas of the basin.

keywords

Groundwater, economics, system dynamics

Using High Speed Photography to Determine Rainfall Droplet Size

Reece Broughton, *New Mexico State University-Alamogordo*

Abstract

Rainfall simulators are commonly used to measure sediment transport, estimate soil erosion and flood runoff in geographic areas. These simulators are often designed for a particular rainfall event (*i.e.,* droplet sizes that mimic the rainfall event) and for the terrain where measurements are needed. Current methods of determining droplet size are inaccurate (*e.g.,* droplets are measured after impacting the ground) and time consuming. This study investigated the use of current digital photography to efficiently and accurately determine the droplet sizes of rainfall. An experiment was conducted in the laboratory to test the use of this technology. The results are pending upon completion of the experiment and data analysis.

keywords

Rainfall, erosion

Catastrophic Forest Fires, Monsoon Rains and Severe Water Quality Degradation in the Rio Grande

Roxanne Candelaria–Ley, *University of New Mexico*
Dr. Clifford N. Dahm, *University of New Mexico*
Chelsea Reale, *University of New Mexico*
Justin K. Reale, *University of New Mexico*
David J. Van Horn, *University of New Mexico*

Abstract

Climate-induced alterations in the forests of the US Southwest are associated with global change as increased temperatures, decreased precipitation, shifts from snow to rain precipitation and decreased snowpack result in drought-stressed vegetation, increased tree mortality and catastrophic forest fires. Wildfires have the potential to dramatically impact the water quality of streams and rivers, especially in xeric climates where water availability is limited. The purpose of this research is to investigate the immediate impact of a 2011 catastrophic fire (Las Conchas) upon the water quality of the Rio Grande. Continuous data for five water quality parameters (temperature, specific conductivity, pH, dissolved oxygen and turbidity) were collected during July and August, 2011 at monitoring sites downstream from the burn zone. Results indicated that severe water quality excursions including acute dissolved oxygen depletions to 0.0 mg/L, abrupt spikes in specific conductivity and extreme increases in turbidity coincided with river discharge pulses resulting from monsoon rains occurring in the burn zone. The decreases in water quality were especially pronounced compared to conditions from previous years before the catastrophic fire. As global climate change is predicted to perpetuate the hot, dry weather patterns of the US Southwest, intense forest fires are likely to occur more frequently. In addition, erratic and often severe monsoon rains will continue to sweep fire-scar runoff into surface waters essential for human water supply and healthy aquatic ecosystems. Continuous water quality monitoring networks provide invaluable information on immediate and persistent changes in rivers and streams impacted by destructive forest fires.

keywords

Forest fire, water quality, climate change

Changes of Epiphytic Diatom Assemblages due to Fire Effects in the Valles Caldera, New Mexico

Alexander Clark, *University of New Mexico*
Dr. Rebecca Bixby, *University of New Mexico*
Dr. Clifford N. Dahm, *University of New Mexico*
Virginia Thompson, *University of New Mexico*

Abstract

Many areas around the world are experiencing increased stress on their water resources. Much of this stress is concentrated in arid and semi-arid regions, which are particularly ill-suited to deal with this difficulty. In both the developing and the developed world alike; shortages and poor water quality, along with growing populations and increased demand for agricultural production, create areas susceptible to water-related crises. Much of this crisis stems from the depletion of aquifers in water stressed areas. Many of these aquifers are being depleted due to mis-management and common-pool resource problems. This paper provides a theoretical framework for the optimal management of a transboundary aquifer. This framework observes the problem as a dynamic game of two agents while allowing for asymmetry in benefit and cost functions of groundwater use. We find that groundwater savings will likely result from a cooperative scenario. A case study is examined in the Middle Rio Grande basin in north-central New Mexico. Systems dynamics modeling is used to simulate coordinated management of aquifer pumping between two cities. It is found that coordinated price increase between the cities of Rio Rancho and Albuquerque can conserve between 600,000-1 million acre-feet of groundwater over the next 30 years. It is also found that coordinated strategies can reduce aquifer draw-down by over 70 feet in some areas of the basin.

keywords

Macrophyte, diatom, epiphyte, Valles Caldera, fire

The Acquisition of Hydrology & Water Quality Equipment for Undergraduate Research &Training at New Mexico Highlands University

Craig Conley, *New Mexico Highlands University*
Dr. Sara H. Brown, *New Mexico Highlands University*
Dr. Edward Martinez, *New Mexico Highlands University*

Abstract

Upon receiving EPSCoR seed grant funding, three faculty members at New Mexico Highlands University (NMHU) have collaborated with the Fish and Wildlife Service (FWS) and the Denver Zoo to establish a long-term, permanent location for our recently acquired hydrology equipment on the Mora River, NM. Funds from this grant are being leveraged with the FWS to install a permanent stream gauging station. Faculty and students have identified several hypothesis-driven questions that will focus on the long-term research program, including: 1) How does changing climate alter the hydrology and water quality of the Mora River; 2) How does restoration work alter the hydrology and water quality of the Mora River, and; 3) How does the removal of invasive species, including Juniper spp. alter the hydrology and quality of the water in the Mora River. Thus far the long-term research site and cutting-edge equipment has been utilized for training purposes, and installed to collect baseline data for six graduate student thesis projects, and one Ph.D. candidate's dissertation work that are focused along the Mora River site. Course curriculum for one course has been revised to include the equipment purchased with the seed grant. Additionally, undergraduate education is being enhanced through class and field trip experiences; 12 undergraduate students visited the site this summer and talked about the long-term data sets that the equipment will provide. We anticipate this long-term research site to continue to provide a better understanding of the hydrology and water quality in our region, as well as a learning platform for undergraduate and graduate students at NMHU.

keywords

Hydrology, water quality, equipment, undergraduate research

Water Quality Assessment of the Valles Caldera Waters in the Jemez Mountains of Northern New Mexico

Rowena Dolino, *Miyamura High School*
Cristina Germino, *Española Public Schools*
Eva F. Abeyta, *Los Alamos Public Schools*

Abstract

Valles Caldera is famous for scientific research mainly because it is volcanic in origin. The students at Miyamura High School and Los Alamos Middle School have done research of the Valles Caldera waters for the following reasons: a) To understand how the 2011 Las Conchas fire has negatively impacted the waters at Middle Jaramillo and East Fork sites, b) To understand the effect seasonal changes have on the waters at these sites, and c) To know if changes have occurred on the quality of the water at these sites from the previous to the current year. The students need to understand that the health of a watershed (rivers, streams, lakes, etc,) depends on the quality of its water. Low water quality represents a dying watershed. To determine the quality of the water at these sites, six parameters have been measured, namely: stream flow, pH, turbidity, total dissolved solids (TDS), dissolved oxygen (DO), and temperature. Temperature, pH, TDS, and turbidity are measured using probes while the Winkler Method measures DO by titration. The stream flow is measured using different flow measuring devices. The results show that the 2011 Las Conchas fire has negatively impacted the waters at the two sites for two years after which the health of the water has been naturally regained. Seasonal changes as well as the yearly tests, two years after the fire, have not shown any negative effect on the health of the waters.

keywords

Valles Caldera, water quality, parameters, impact

Understanding Nitrite Dynamics across Three Burn Severities in the Las Conchas Fire

Elyssa Duran, *New Mexico Highlands University*
Anita Lavadie, *New Mexico Highlands University*
Dr. Sara Brown, *New Mexico Highlands University*
Dr. Edward Martinez, *New Mexico Highlands University*

Abstract

In recent years, fire experts along with resource managers have seen a dramatic increase in wildland fire severity and spatial extent. The purpose of this study is to investigate the concentration of nitrite (NO2) levels in soils originating in four wildfire severity classes (control—unburned, low, moderate, and high severity) from the Las Conchas fire (2011) in the Valles Caldera National Preserve, located in the Jemez Mountains, New Mexico. We anticipate that moderate severity soils will yield the most nitrite, high severity will yield a moderate amount, and low severity will yield the least. The Valles Caldera National Preserve (VCNP or Caldera) is located in the northern New Mexico Jemez Mountains approximately 18 miles northwest of Los Alamos, New Mexico. At each of the different fire severity sites there are five randomly selected plots from which soil samples were taken once a month. Soil was taken out of brown paper bags and sifted to a 0.5mm diameter. In order to be able to analyze soil samples, soils had to be leached. Nitrite (NO_{2-} -N kg -1) concentrations were determined using the OI Analytical FS 3100 Automated Chemistry Analyzer (OI Analytical,1963) utilizing method USEPA Method 353.2. Our results suggest nitrite (NO_{2-} -N kg -1) concentrations are exceedingly low across all burn severities for two sample dates.

keywords

Las Conchas fire, nitrites, VCNP

Effects of Climate Change on Arsenic Concentrations in Surface Waters and Stream Sediments in the Jemez Mountain Region, New Mexico

Lorraine Garcia, *New Mexico Highlands University*
Dr. Edward A. Martinez, *New Mexico Highlands University*
Daryl Williams, *New Mexico Highlands University*

Abstract

The Jemez Mountains, located in north central New Mexico, are known for containing one of the largest volcanic craters in the world, the Valles Caldera. It is also home to an extensive network of hydrothermal springs and seeps created by the large geothermal reservoir which lies beneath the crater. These hydrothermal springs and seeps, along with the geology contribute large amounts of heavy metals, most importantly arsenic, to the waters and sediments of the Jemez River and its tributaries. Due to climate change, over the past five decades average annual temperatures have risen 2oF, while average annual precipitation has decreased three inches in this region. With global climate change predictions of shorter and warmer summers it is plausible to conclude that runoff from snow pack will decrease while the geothermal spring contribution of water to the streams will increase in proportion. It is believed that understanding the distribution and fate and potential hazards of arsenic contributed during these changing conditions is crucial in determining how the changing climate will impact New Mexico's high mountain streams and their biota. Results from this study indicate that seasonal variations of arsenic concentrations in water and sediments are dictated by a variety of site specific conditions, as well as physiochemical parameters.

keywords

Jemez Mountains, arsenic, climate change, hydrothemal-water, sediment

Management Prescription – Cañadas Bonitas, New Mexico

Benjamin Gonzales, *New Mexico Highlands University* Dr. Sara Brown, *New Mexico Highlands University*

Abstract

Due to inconsistent annual precipitation, high tree densities and large insect and pest populations, the 120 acre tract has experienced high tree mortality, particularly in Piñon Pine (*P. edulis*), which has contributed to topsoil loss, fuel loads and fire risk. Located within a high desert, precipitation in the area occurs mainly during the monsoon season. *Pinus edulis* has been widely impacted by piñon needle scale (*Matsucoccus acalyptus*). This hemipteran feeds on the sap of the previous years needles and males remain beneath the duff of host trees. Repeated feedings weaken the trees and they eventually fall victim to the bark beetle *Ips confusus*. One-seed Juniper *(Juniperus monosperma*) has experienced an increase in mistletoe (*Phoradendron juniperinum*), which parasitizes the tree. The moderate slope of the property, sparse vegetation and high clay content of the soil have contributed to sheet flow which has created arroyos in excess of 8' deep. This has led to a significant loss of topsoil from the property. Frequent, high winds in a dense stand of ponderosa pine (*P. ponderosa*) increase the likelihood of flame spread on the west end of the property.

keywords

Erosion, desertification, land management

Study of Phosphate Removal from Algal Cultures

Amanda Lara, *New Mexico State University*

Abstract

The petroleum based fuel, widely used today is unsustainable due to carbon dioxide emissions, and decrease in fossil fuel reserves. A potential alternative source would be algal biodiesel due to its renewability, low emissions and ease of cultivation in all seasons with no demand for freshwater. In addition to being a renewable energy source, algal cultivation in wastewater could be used to remove nutrients from wastewater. The goal of this study was to evaluate growth of a green algae *Scenedesmus obliquus* using primary effluent in photobioreactors and to determine phosphate removal. Two photobioreactors (A and B) were initiated with identical nutrient concentrations (3 mM ammonia and 1.73 mM phosphate) for algal growth. As soon as the ammonia in cultures reached saturation phase, one of the reactors (A) was again seeded with full dose of ammonia (3 mM) with the reactor B as a control. Phosphate removal efficiency of 93.6% and 99.9% was achieved in reactor A and B with corresponding productivities of 0.075 and 0.081 g L^{-1} d^{-1}.

keywords

Biofuels, phosphates

Site Characteristics of Ponderosa Pine Regeneration Following High Severity Fire

Aspen Lowance, *Northern New Mexico College*
Dr. James Biggs, *Northern New Mexico College*
Dr. Mario Montes–Helu, *Northern New Mexico College*

Abstract

The southwest has been experiencing devastating large scale intense forest fires due to historical overgrazing, fire suppression and repeated severe droughts beginning in 2000 has led to a buildup of dry fuels (Haire & McGarigal, 2010). The recent spread of fires that the southwest has been experiencing have a significant effect on forest watersheds. Low intensity fires and prescribed burns show little effect on watersheds while during high severity fires vegetation and ground cover are lost, causing hydrophobic soils leading to high soil loss across landscape. The recovery of a watershed after a high severity fire may range from a few years to decades (Neary et al., 2003). With these fires and the loss of forest water sheds there has been increasing concerns for the loss of ponderosa pine and other plant species. The regeneration of ponderosa pines and other plant species after moderate to high severity burns, chances for forest watersheds increase, allowing for water absorption and maintaining biodiversity in the south west.

keywords

Ponderosa pine, fire, high severity fire

Copper Resistant *Pseudomonas* sp. from the Nacimiento Copper Mine Pit Lake Combined with Biochar Amendments Immobilize Copper

Rachael Lucero, *New Mexico Highlands University* Dr. Richard Plunkett, *New Mexico Highlands University*

Abstract

We investigated the ability of copper resistant bacterial strain 12B-2 (*Pseudomonas* sp.) from the pit lake of an abandoned copper mine to remove copper contamination from water. Mining of copper has resulted in environmental contamination, requiring remediation efforts—many of which are ineffective. While copper is toxic in large quantities, some bacteria are able to survive in contaminated environments. We have isolated 12 bacterial strains of the genera *Pseudomonas* and *Acinetobacter* from sediments in copper-contaminated waters from the pit lake near the abandoned Nacimiento Mine in Cuba N.M. All organisms show resistance to toxic levels of copper, and one (*Pseudomonas* sp. strain 12B–2) can grow in extremely high levels of copper, and has an inducible response to $CuSO_4$, suggesting the presence of genetic elements that confer resistance. Purpose: The effects of these bacteria on the concentration of copper sulfate ($CuSO_4$) were the subject of these investigations and to identify the genetic basis behind the copper resistant in *Pseudomonas* sp. Hypothesis: Strain 12B–2 will use mechanisms found in other copper resistant *Pseudomonas* sp. to immobilize $CuSO_4$ and addition of biochar will increase this activity and that the copper tolerance of strain 12B-2 is due to genetic factors.

keywords

Copper resistant, Biochar Amendment

2013 EPSCoR Internship

Kodie Lynn Martinez, *Luna Community College*
Richard McNeill, *Luna Community College* Joe Zebrowski, *New Mexico Highlands University*

Abstract

The purpose of this project was to give students an opportunity to work with land managers and researchers facing climate change in their day to day activities. I spent the summer working with the Geospatial Applications In Natural Science (GAINS) Lab at New Mexico Highlands University. I learned to use various geographic information systems including ESRI ArcGIS, Google Earth, Trimble GPS, and Garmin GPS. With these skills I collected and mapped research and infrastructure at three National Wildlife Refuges and at other properties undergoing restoration designed to make them more resilient in the face of climate change., I also had the opportunity

to teach them to others, including National park Service employees at Pecos National Historic park and U. S. Fish and Wildlife Service Youth Conservation Corps Workers at Rio Mora NWR. In learning and applying these new skills, I developed a better understanding of the challenges researchers and land mangers experience and an appreciation for the value of geographic information in their work.

keywords

EPSCoR, internship, outreach

Building the Capacity to Monitor Climate Change and Manage Lands to Minimize Climate Impacts in New Mexico

Richard McNeill, *Luna Community College* Joe Zebrowski, *New Mexico Highlands University*
Kodie Lynn Martinez, *Luna Community College*

Abstract

Plants are the one of the most critical elements of the environment affected by climate change. The temporal changes in temperature and hydrology affects phenology, distribution and diversity of plants species. These changes will have one of the greatest impacts on human populations. Understanding how plants respond to climate change will enable researchers and land managers to evaluate and modify management practices to minimize the impacts on the plants of an area as a result of climate change. This project has two approaches. The first is to increase the infrastructure that supports botanical education and research for students and professionals. This would include equipment and teaching materials. These tools would help ensure that students have the best possible understanding of the processes and issues related to plants, hydrology and climate change. Students and professionals should be familiar with the tools and procedures used to understand and manage these issues, and have access to the tools and research material needed for effective research and management. The second approach is to provide opportunities for students to work with scientists and land managers. This experience would provide students with a valuable understanding of the complexities and requirements of working in the natural resource field in a changing climate.

keywords

Internship, vegetation, monitoring

HSP70 Gene Expression and Morphological Abnormalities in Larval Chironomidae as Indicators of Stress Response to Chronic Sediment-Copper Exposure

Sebastian Medina, *New Mexico Highlands University* Dr. Edward Martinez, *New Mexico Highlands University*
Dr. Sarah Corey-Rivas, *New Mexico Highlands University*

Abstract

The goal of this study is to investigate the toxicological impacts of sediment-copper pollution in the Peterson Reservoir (Las Vegas, NM) using HSP70 gene expression and morphological abnormalities in chironomidae (midge) larvae as indicators of physiological stress response. To accomplish this goal, concentrations of copper in the sediments of Peterson Reservoir will be determined. It will also be determined if sediment-copper concentrations affect HSP70 gene expression and/or morphological abnormalities among midge larvae present within Peterson Reservoir. Finally, it will be determined if copper is bioaccumulating in midge larvae present within Peterson Reservoir. It is anticipated that midge larvae present within Peterson Reservoir will demonstrate elevated levels of HSP70 gene expression relative to control larvae collected from Morphy Lake (Mora, NM; natural control) and

a laboratory culture of *Chironomus riparius*. It is also expected that midge larvae collected from Peterson Reservoir will exhibit higher proportions of morphological abnormalities in comparison to control larvae. Collective screening for HSP70 gene expression and morphological abnormalities among midge larvae provide sensitive and efficient biomonitoring strategies in understanding and detecting toxicological impacts of heavy metal contamination on the health of aquatic ecosystems.

keywords

Chironomidae, morphology, abnormalities, genotoxicity, copper

Fluorescent and X-ray Structural Studies of Nano-porous Materials

Carlos Ordonez, *New Mexico Highlands University* Tatiana Timofeeva, *New Mexico Highlands University*
Qiang Wei, *New Mexico Highlands University*

Abstract

In order to find materials used for sensing carbon dioxide and other chemicals, we synthesized various nano-porous materials also known as Metal-Organic Frameworks (MOFs). By varying the ligands (organic linkers), salts (metal clusters) and solvent systems we would like to observe how the structure of our compound changes, and how these changes affect the fluorescent emission of the compound. So far, we have synthesized two major MOF systems that include Zinc-Tetrazolyl Benzene Carboxylate (TBC) and Zinc- 1, 3, 5-Benzene Tri Carboxylate (BTC). X-ray crystallography for Zn-TBC shows a porous structure with strong Zn-N and Zn-O bonds. The fluorescent spectrum of Zn-TBC demonstrates that the MOF is dependent on the excitation wavelength to produce a different emission wavelength. On the other hand, Zn-BTC systems showed that the crystal frameworks are cation-templated, and interactions between the cations with the frameworks and solvents influenced the emission of the MOF. Detailed studies of the solid-state fluorescent spectra of the two MOF systems upon the structure and interaction changes will be reported and discussed in the poster.

keywords

Metal-Organic Frameworks, ligands, metal clusters, X-ray crystallography, fluorescence

The Impact of Invasive Bullfrogs on the Demographics of Northern Leopard Frogs in Northern New Mexico

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Micah Daboub, *New Mexico Highlands University* Steven Salinas, *New Mexico Highlands University*
Dr. Jesús Rivas, *New Mexico Highlands University*

Abstract

Invasive species are able to alter the dynamics of the trophic levels of an ecosystem, having no natural controls they can displace native species in the food web, to prey on species with no adaptive defenses. The Rio Mora National Wildlife Refuge has both invasive Bullfrogs and native Northern Leopard Frogs. The extent to which the bullfrogs have impacted the native Northern Leopard Frogs has not been previously studied. The purpose of this study is to investigate the effects of the presence of the invasive Bullfrog on the demographics of the native Northern Leopard Frog in northern New Mexico. A section of the Mora River in the refuge was divided into two 2000-meter long section a control site containing Bullfrogs and an experimental site where Bullfrogs were eradicated. Relative abundance surveys were utilized to sample demographic parameters. Fifty one Leopard frogs were captured, pit tagged, and processed for demographic data. Control and experimental regions did not differ in the relative abundance of the leopard frogs. We did not find a significant difference in the mass of frogs from the two regions. However,

preliminary data does show lower average mass and greater abundance in the experimental region suggesting an increase in recruitment of metamorphosis frog into the population. A change in demography within a year of bullfrog removal shows how fast a species can react to environmental changes.

keywords

Amphibians, invasive, bullfrogs, leopard frogs

Montane Riverine and Wetland Conditions of the Gallinas Watershed Using the New Mexico Rapid Assessment Method

Rose Peralta, *New Mexico Highlands University* Benjamin Gonzales, *New Mexico Highlands University*

Abstract

The Gallinas Watershed supplies the local town of Las Vegas, NM with 90% of its drinking water making it a priority to study the conditions of the wetlands, rivers and streams within the watershed (Hermit's Peak Watershed Alliance, 2013). Wetlands play a crucial role within a watershed by storing water, filtering water, flood abatement and the support of large diversity of fish, wildlife and plant populations. Land use along the Gallinas River has been gravely altered by humans for agriculture, horticulture, urbanization and ranching. The purpose of this study was to determine the conditions of wetlands in and adjacent to the Gallinas River using the New Mexico Rapid Assessment Method (NMRAM). It was hypothesized that the land management in the watershed has had a negative effect on the health of the Gallinas Watershed. Following the NMRAM protocol wetlands within the canyon were initially identified using data bases from the following sources: Google aerial photographs; US Forest Service plant inventories and historical documentation; US Fish and Wildlife Service National Wetlands inventory; Endangered and threatened species inventory and the Natural Resources Conservation Service soil maps. Landscape characteristics were established from the geology, geo-hydrology, climate, surface hydrology, water quality, soils, vegetation communities, wildlife habitat, land ownership and land use. The most altered channelized areas including urban interface were the experimental sites and the protected untouched areas were the control sites. Geomorphology measurements, plant species identification and buffer zones were calculated. Using measurements from these parameters a scoring ranging from 4.1–1.0 was calculated for each site and given a grade, A–D; A=Excellent, B=Good, C=Fair, and D=Poor. Preliminary results indicate that heavily grazed and altered river morphology areas had low scores according to NMRAM. Specifically these areas had high concentrations of invasive species, entrenchment, and erosion.

keywords

Wetland assessment, Gallinas River assessment, riverine conditions, watershed health

Scalable Wind and Hydropower Energy Resource (SWHyPER) Harvesting Systems

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Javitt Higmar Padilla–Franko, *New Mexico State University* Nyugen Hun Phuc, *Vietnam Fulbright Scholar*

Abstract

Among the three principal energy providing sources in Nature, water is notably the foremost in its abundance, and the purpose which it serves towards sustaining life on Earth. Air and the effects of the Sun together provide the balance for maintaining the atmosphere needed for life-support and evolution on Earth. The goal in harvesting should be to harness as much energy that one needs, and to leave the environment undisturbed in its original form and appearance. This would be the right thing to do so future generations can experience the benefits of the natural

renewable energy resource, and enjoy the natural beauty in the environment. Under extreme weather conditions, such as during hurricanes and cyclones, it is a combination of energy from high wind and floodwater resources that must be harnessed so that emergency power needs of shelters and emergency centers can be easily me. Naturally, this will improve the conditions for human health and safety and aid in rapid restoration and recovery from natural disasters. The question, therefore, is how and from where we can utilize natural energy when we need it most. The poster presents a spectrum of technological innovations to harvest energy from water and wind during extreme weather.

keywords

Sustainable, power, environment, energy, renewable

Synergistic Effects of Climate Change, Wildfire, and Severe Water Quality Degradation on the Aquatic Ecosystems and Ichthyofauna

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Abstract

Since the 1900's, wildfire frequency and severity in the southwestern U.S. has increased despite human suppression efforts. Watershed impacts, including accelerated flooding and erosion, are common after high intensity crown fires. Accelerated riverine sedimentation, following wildfires, can negatively impact water quality and aquatic ecological health. Impacts may include increased sediment oxygen demand resulting in dissolved oxygen sags and fish kills. In 2011, the Las Conchas Fire burned ~157,000 acres in central New Mexico. Subsequent monsoonal precipitation events occurring within the burnt watershed resulted in altered downstream water quality and documented fish kills. Continuous water quality monitoring stations (2006-present) will be used to compare pre and post-fire water quality parameters (pH, temperature, dissolved oxygen, turbidity, and specific conductance) at four stations in the Middle Rio Grande (MRG). Water quality data will be combined with NOAA NEXRAD data and monthly fish community monitoring in the MRG sites by American Southwest Ichthyological Researchers (2002-current) to assess the impacts of a high intensity crown fire on water quality and fish communities in the Middle Rio Grande. Results will provide insight into the effects of a significant disturbance to southwestern aquatic ecosystems, which are likely to increase in frequency over the next several decades.

keywords

Fire, fish community, Rio Grande, NEXRAD, water quality

Habitat Assessment and Benthic Macroinvertebrate Bioassessment of the Santa Fe River Below Nichols Reservoir, Santa Fe County, New Mexico, 2010-2012

Ernesto Sandoval, *New Mexico Highlands University*
Daryl Williams, *New Mexico Highlands University*
Sebastian Medina, *New Mexico Highlands University*
Dr. Edward A. Martinez, *New Mexico Highlands University*

Abstract

High elevation areas, such as the Valles Caldera National Preserve (VCNP) located in the Jemez Mountains of Northern New Mexico, have been described as exceptionally vulnerable to changes in climate and thus offer an ideal window to monitor temperature changes and their possible implications. In the present study, we examined the effects diurnal and seasonal water temperature changes and discharge have on water quality. Two water sampling regimes (diurnal and grab samples) were employed from May 2010 to May 2012 at four sites along two potentially vulnerable headwater streams located within the VCNP. Concentrations of primary nutrients (nitrate, nitrite, and phosphate), dissolved organic carbon, and other solutes (bromide, chloride, fluoride, and sulfate), along with discharge and physicochemical parameters (conductivity, dissolved oxygen, pH, and turbidity) served as indices of

water quality. The results of this study indicated that primary nutrients and other solutes were sensitive to seasonal temperature changes, but that their sensitivity was modulated by the unique characteristics of sample sites. Effects of seasonal water temperature fluctuations on primary nutrient and other solute concentrations can offer a deeper understanding of challenges headwater streams may face as result of anticipated climate changes.

keywords

Headwaters, streams, nutrients/solutes, temperature, water quality

Working with GIS, Summer of 2013

Oscar Sena, *Luna Community College*

Richard McNeill, *Luna Community College*

Joe Zebrowski, *Luna Community College*

Abstract

The purpose of this project was to give students an opportunity to work with land managers and researchers facing climate change in their day to day activities. I, Oscar Sena spent the summer working with the Geospatial Applications in Natural Science (GAINS) Lab at New Mexico Highlands University. I became proficient in the use of various geographic information systems including ESRI ArcGIS, Google Earth, Trimble GPS, and Garmin GPS. I used the systems to map infrastructure, restoration, and research projects at nearby National Wildlife Refuges, private properties undergoing publically funded restoration projects, and the City of Las Vegas, NM. I also provided GPS training to National Park Service staff and interns and to U.S. Fish and Wildlife Service Youth Conservation Corps employees. I also assisted a local private surveyor in field data collection, data analysis, and drafting. These experiences provided me with a better understanding of the resource management challenges researchers and land mangers experience and motivated me to explore education and career opportunities in surveying and geographic information systems. The results of this was, I learned about how we can benefit from these natural resource skills, also a few maps were created of the infrastructure data at 3 of the nearest wildlife refuges.

keywords

EPSCoR, internship, GIS

Dissolved Oxygen Content and Temperature Readings in Relation to pH Levels, and Capacity of Conchas Reservoir, New Mexico

Stephen Smith, *Mesalands Community College*

Abstract

Dissolved oxygen content is a measurement used in water research to determine the amount of oxygen particles dissolved into a body of water. Dissolved oxygen is measured in mg/L or parts per million (ppm). A body of water that is well-mixed is said to be saturated if there are about 10 mg/L in 15°C water and fluctuations in temperature can cause the dissolved oxygen content to change. This measurement is very important in the ecological sense. An entire ecosystem can be disrupted by the slightest sustained change in dissolved oxygen because the ratio of aerobic to anaerobic species can be disrupted. This research will consider dissolved oxygen levels in north-eastern New Mexico's Conchas Reservoir in relation to the average pH levels and water temperature levels from four different data collection points throughout the lake for the years 2010 to 2012. Considering data provided the Army Corps of Engineers members at Conchas Dam, as well as data collected by Mesalands Community College students, one can observe an inverse relationship between water temperature and dissolved oxygen readings as well as a correlation between the relative percentage of storage capacity used in a body of water to the water's median pH value.

keywords

Dissolved oxygen, Conchas Reservoir, temperature, water

Management of Saltcedar along the Rio Grande Through Long–Term Evapotranspiration Monitoring

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Dr. A. Salim Bawazir, *New Mexico State University*
Brent Tanzy, *U.S. Bureau of Reclamation*
Dr. Richard G. Luthy, *Stanford University*

Abstract

A study at Caballo Reservoir on long-term evapotranspiration (ET) measurement of managed saltcedar (*Tamarix* spp.) area was conducted from 2009 through 2013. The ET of saltcedar was measured using energy budget and eddy covariance technique at a site near the Rio Grande at Palomas, New Mexico. Saltcedar was managed by herbicide and mowing during the course of the study. The objective was to determine the ET depletion of exotic saltcedar area under practiced management by the United States Bureau of Reclamation. ET data was collected on 30-minute basis and totaled to determine daily values. A maximum ET of 1274 mm was measured when the saltcedar was left unmanaged. However, ET varied when it was managed. The findings of the study suggest a change in policy regarding the practiced management, may result in ET depletion reduction, suppression of saltcedar from spreading, and may prove cost effective.

keywords

Evapotranspiration, policy, Rio Grande, saltcedar

Groundwater/Surface Water Interaction in a Losing Reach of the El Rito Watershed

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Vanessa Ward, *New Mexico Tech*
Keith Cooker, *New Mexico Tech*
Trevor Schlossnagle, *New Mexico Tech*
Elizabeth Tysor, *New Mexico Tech*
Dr. John Wilson, *New Mexico Tech*
Dr. Marty Frisbee, *New Mexico Tech*
Lani Tsinnajinnie *New Mexico Tech*

Abstract

Understanding the interactions between groundwater and surface water is critical to the future sustainability of communities in semi-arid watersheds because streamflow is often the primary source of water for diversions, *acequias*, and irrigation. Recharge and runoff are largely seasonally limited to the snowmelt season. As a consequence, sustained streamflow through the remainder of the year often depends on a greater fraction of groundwater. This warrants further investigation into streamflow generation processes and groundwater/surface water interactions in semi-arid watersheds. For example, in the El Rito watershed, a mountainous, sedimentary watershed in northern New Mexico, groundwater/surface-water interactions are very complex and an overall losing trend in discharge emerges with increasing drainage area. The losing trend appears to emerge along an 8 km reach of the stream where both major extensional faults and numerous beaver ponds are present. Either or both of these features could potentially account for the increased loss of water along this reach; 1) enhanced losses of water due to evaporation and/or infiltration from beaver ponds, and 2) losses of water due to changes in permeability associated with the extensional faults. In order to test the first possible cause of water loss, we conducted high-resolution stream gauging and water sampling for chemistry at 14 sites along the reach. In order to test the second possible cause of water loss, we conducted resistivity surveys at 3 locations near and below the major extensional faults to quantify the impacts of the faults on the local groundwater water table. Two surveys were conducted at each location. Our data shows that beaver ponds are not responsible for the loss of water along this reach. However, the data from the resistivity surveys indicates that local groundwater tables are impacted by the faults and this may affect groundwater/surface water interactions along the losing reach.

keywords

Semi-arid watershed, Resistivity survey, Extensional fault, Stream Gauging, streamflow generation

The Cost of Wildfire in the West

Kara A. Walter, *University of New Mexico* Dr. Janie Chermak, *University of New Mexico*

Abstract

Wildfires in the west have increased in both frequency and size over the last several years. Different management schemes have been argued, but no definitive course has been set. To put these alternatives in perspective, not only is it necessary to consider the impact on the probability of a wildfire occurring, but also the expected cost of that wildfire. In order to compare these alternatives, an estimate of the total cost of a wildfire is necessary. While suppression costs are readily available, full costs associated with wildfire are not. As a first step, we develop a framework of costs for a western wildfire, differentiated spatially and temporally. Costs are separated into six broad categories, first by location (burn area and non-bur area) and second by time (immediately verses long-term and/or one-time versus recurring). We also distinguish between market and non-market costs. For example, one-time costs include suppression and evacuation costs; recurring costs include increased seasonal flooding over time; and non-market costs include loss of cultural sites. This framework is applied to the Las Conchas Fire, which burned over 156,000 acres in New Mexico in 2011 and was, at that time, the largest wildfire in New Mexico history. Using estimating techniques from previous literature, primary data where possible, and benefit-transfers where necessary to determine the full cost to the state of New Mexico. In the case of the Las Conchas, the suppression costs alone were over $48 million, but the lower bound on estimable costs is $200 million.

keywords

Economic costs, wildfire, Las Conchas, New Mexico

Habitat Assessment and Benthic Macroinvertebrate Bioassessment of the Santa Fe River Below Nichols Reservoir, Santa Fe County, New Mexico, 2010-2012

Clint West, *New Mexico Highlands University* Dr. Gerald Jacobi, *New Mexico Highlands University*
Dr. Edward A. Martinez, *New Mexico Highlands University*

Abstract

The Santa Fe Municipal Watershed provides water for approximately 30, 000 households and businesses within the City of Santa Fe. Historical landuse and management practices have resulted in negative impacts to the Santa Fe River and its riparian corridor. Impacts to the Santa Fe River include increased sedimentation and removal of riparian vegetation. The purpose of this study was to establish a baseline for monitoring projects and to contribute to the design for future restoration elements. To accomplish this, an assessment was conducted of the riparian habitat and macroinvertebrate community. In addition, thermographs were installed to monitor water temperature changes. The Family Biotic Index indicated an average score of 5.25 with a water quality rating of Fair. The habitat assessments indicated that this reach of the river is not in optimal condition. High temperatures, lack of bank vegetation and stability, lack of sinuosity (channelized morphology) all contributed to the Fair water assessment as expressed by the macroinvertebrates. The findings of this study provide valuable information for similar studies in the future. It will also aid in determining the types of restoration that should be implemented in the future to increase the health of this system.

keywords

Macroinvertebrates, temperature, bioassessment, riparian, restoration

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