Technical Session Abstracts

Invasive Mollusks & Benthic Habitats

March 16, 2010
1:00 p.m. – 2:40 p.m.
Room 139

The Asian Clam Invasion in Lake Tahoe:
The Ecology of an Invasive Bivalve in an
Oligotrophic Lake
- Marion Wittmann, Ph.D.

Life History Strategies of the Asian Clam, *Corbicula Fluminea*,
in Lake Tahoe
- Marianne Denton

The Management of Asian Clam in Lake Tahoe:
Bottom Barriers & Diver Assisted Suction Removal
- Marion Wittmann, Ph.D.

Risk of Invasion or Really No Problem?
An Experiment Test of Quagga Mussel Survival
& Reproductive Status Using Lake Tahoe Water
- Sudeep Chandra, Ph.D.

Long-Term Change in Benthic Invertebrate Assemblages
in Lake Tahoe, California/Nevada
- Andrea Caires

The Asian Clam Invasion in Lake Tahoe: The Ecology of an Invasive Bivalve in an Oligotrophic Lake

Marion Wittmann, Ph.D.*
John Reuter, Ph.D.
Geoff Schladow, Ph.D.
Brant Allen
Tahoe Environmental Research Center
University of California, Davis

Sudeep Chandra, Ph.D.
Department of Natural Resources and Environmental Science,
University of Nevada, Reno

***University of California, Davis, Tahoe Environmental Research Center, 291 Country Club Drive, Incline Village, Nevada 89451. (775) 881-7560 x 7402, mwittmann@ucdavis.edu**

Funding source: Lake Tahoe Southern Nevada Public Lands Management Act, US Forest Service Lake Tahoe Basin Management Unit, Nevada Division of State Lands License Plate Fund, Lahontan Regional Water Quality Control Board Clean Up Abatement Fund, United States Army Corps of Engineers

The invasive bivalve Asian clam (*Corbicula fluminea*) was first recorded in Lake Tahoe with sparse populations in 2002. In 2008 large densities of Asian clam were observed in the Southeastern region of the Lake. The invasive behavior of Asian clam is due to its high growth, reproduction and feeding rates and often enables this species to outcompete native species, and potentially alter ecosystem function. Lake Tahoe's high altitude, oligotrophic cold waters impact typical life history patterns of invasive plants and limit the reproductive and feeding season for introduced warmwater fishes. Asian clam life history traits are determined by temperature thresholds and food availability. Limitations to growth, reproduction and distribution of this species in a coldwater, subalpine ecosystem have important ecological and management implications for aquatic invasive species.

Field sampling was conducted between October 2008-December 2009 at various locations, with focus in the southeastern portion of the nearshore. Species densities, distribution and benthic community composition were collected by SCUBA and benthic grab sampler surveys.

A summary of the current distribution, abundance and population structure of Asian clam in Lake Tahoe will be presented, with comparisons to other systems.

Lake Tahoe Asian clam populations reach densities >3000/m^2 and are distributed widely along the littoral zone along the southeastern region. Average Tahoe Asian clam size is smaller, but growth rates and population densities are similar and can exceed those in warmer, higher nutrient systems. Population expansion of this species within Lake Tahoe is continuing.

Life History Strategies of the Asian Clam, *Corbicula Fluminea*, in Lake Tahoe

Marianne Denton*
Environmental Sciences Interdisciplinary Graduate Program,
University of Nevada, Reno

Sudeep Chandra, Ph.D.
Department of Natural Resources and Environmental Science, University of Nevada, Reno

Marion Wittmann, Ph.D.
Tahoe Environmental Research Center, University of California, Davis.

***UNR, 1000 Valley Road, Mail Stop 186, Reno, Nevada 89512. (775) 784-3515**
mariannedenton@sbcglobal.net

The Asian clam, *Corbicula fluminea*, has established high-density populations throughout the nearshore zone of southeastern Lake Tahoe. First observed in 2002 in low densities, current high-density clam beds (greater than 2000 clams per square meter in some locations), may affect macroinvertebrate populations, couple the pelagic to the benthic by altering nutrient cycling and under optimal conditions, have the potential to out-compete native Lake Tahoe benthic species.

Life history mechanisms of Asian clams in Lake Tahoe are determined by assessing fecundity through field and laboratory studies, ascertaining substrate preferences in laboratory studies and assessing the impacts to benthic biodiversity by Asian clam populations. While other locations with documented populations have high levels of fecundity (a documented release of 600 juveniles in twenty-four hours), completed Asian clam fecundity studies in Lake Tahoe have yielded little to no recruits which may reflect the actual fecundity of the clams, the sampling period and/or other methological issues.

This presentation will review studies conducted throughout 2009 and plans for 2010. The findings will eventually assist in understanding Asian clams' population potential to spread to novel substrates as indicated by an understood level of fecundity and how that may affect Lake Tahoe's benthic invertebrate communities.

The Management of Asian Clam in Lake Tahoe: Bottom Barriers & Diver Assisted Suction Removal

Marion Wittmann, Ph.D.*
John Reuter, Ph.D.
Brant Allen
Geoff Schladow, Ph.D.
Tahoe Environmental Research Center,
University of California, Davis

Sudeep Chandra, Ph.D.
Department of Natural Resources and Environmental Science,
University of Nevada, Reno

***University of California, Davis, Tahoe Environmental Research Center, 291 Country Club Drive, Incline Village, Nevada 89451. (775) 881-7560 x 7402, mwittmann@ucdavis.edu**

Funding source: Lake Tahoe Southern Nevada Public Lands Management Act, US Forest Service Lake Tahoe Basin Management Unit, Nevada Division of State Lands License Plate Fund, Lahontan Regional Water Quality Control Board Clean Up Abatement Fund

The range expansion of Asian clam (*Corbicula fluminea*) in Lake Tahoe has prompted experimentation with non-chemical control strategies. Asian clam are a successful invader due to their ability to survive in a wide range of environmental thermal, chemical and resource limited conditions. The literature suggests this tolerance makes Asian clam difficult to control. Asian clam have been reported to be intolerant of acute hypoxia and are generally absent from chronically hypoxic waters. To date, there are no published records of complete Asian clam eradication in a natural ecosystem and most control strategies only reduce populations.

In 2009 two non-chemical management techniques—the use of diver assisted suction removal and the application of rubber bottom barriers were implemented on a small pilot scale at two sites in Lake Tahoe. In-lake, experimental plots are initially monitored to track the rate of dissolved oxygen loss under the rubber barriers. Asian clam mortality and recolonization were subsequently monitored for a 9 month period.

A summary of pre-treatment and post-treatment conditions for the two management strategies will be presented.

Diver assisted suction removal is effective at reducing Asian clam and native macroinvertebrate communities. However, recolonization of these plots occurs, and financial costs are high. Bottom barrier application resulted in 100% Asian clam and 70-95% benthic macroinvertebrate mortality after a 28-day period from August to September 2009 in a mean water temperature of 18ºC. A cost and feasibility analysis of large-scale barrier application in Tahoe is under consideration.

Risk of Invasion or Really No Problem? An Experiment Test of Quagga Mussel Survival & Reproductive Status Using Lake Tahoe Water

Sudeep Chandra*, Ph.D.
Annie Caires
Lisa Atwell
Department of Natural Resources & Environmental Science,
University of Nevada, Reno

Marion Wittmann, Ph.D.
John Reuter, Ph.D.
Geoff Schladow, Ph.D.
Tahoe Environmental Research Center, University of California, Davis

Ted Thayer
Tahoe Regional Planning Agency

***Department of Natural Resources & Environmental Science, University of Nevada, Reno, 1000 Valley Road, Mail Stop 186, Reno, Nevada 89512. (775) 784-6221, sudeep@cabnr.unr.edu**

The recent establishment of non-native dreissenid mussel species (quagga and zebra) in the western United States is creating concern amongst regional water resource managers, scientists and other recreational and commercial users of waterways. At Lake Tahoe the Tahoe Regional Planning Agency and other agencies have enacted regulations boat washing programs to reduce the probability of introduction of this species to the lake. It remains unclear whether Lake Tahoe's physical habitat can support their establishment. Previous models for dreissenid mussel establishment are minimum threshold driven, based mostly on dissolved calcium levels. To understand the potential for adult quagga mussel to survive when exposed to a Lake Tahoe conditions (i.e. low calcium, oligotrophic cold waters) in a laboratory setting. The laboratory experiment showed that quagga mussel had 87% survival with a positive growth rate over the experimental period. Reproductive status was variable with 43% of individuals (male and female) showing sperm and oocyte production, 14% were in a post-spawn phase, and 29% showed resorption. The regional invasion of dreissenid, and more specifically quagga mussel in the Western United States is currently not well understood due to data gaps for this particular species, and the lack of a clear relationship between water column calcium levels and the probability of establishment. We recommend monitoring and prevention efforts in Lake Tahoe for quagga mussel and other potential aquatic invasive species. This project was funded by the Army Corps of Engineer funds to the Tahoe Regional Planning Agency and University of Nevada funds to S. Chandra.

Long-Term Change in Benthic Invertebrate Assemblages in Lake Tahoe, California/Nevada

Andrea Caires*, Ph.D.
Sudeep Chandra, Ph.D.
Department of Natural Resources and Environmental Science, University of Nevada, Reno

Marion Wittmann, Ph.D.
Geoff Schladow
Tahoe Environmental Research Center, University of California, Davis

*** University of Nevada, Reno, Department of Natural Resources and Environmental Science, 1000 Valley Road, Mail Stop 186, Reno, Nevada 89512. (775) 784-6646, acaires@cabnr.unr.edu**

This project was funded via funding provided by the Army Corps of Engineers to the California Tahoe Conservancy.

Benthic invertebrates in deepwater lakes are important from an ecological perspective for the maintenance of endemism and biodiversity and also from a management perspective for the maintenance of fisheries. Benthic invertebrates are useful biological indicators because of their sensitivity to changes in biological and physical characteristics of lakes. Both the biological and physical characteristics of Lake Tahoe have changed substantially since the 1960s, when the last comprehensive benthic invertebrate survey was conducted. To document differences in the benthic invertebrate community in Lake Tahoe since the 1960s, we collected benthic invertebrate samples along 4 transects (Crystal Bay, McKinney Bay, Stateline, and Camp Richardson) from June-August 2008 and May-September 2009. Samples were collected at similar depth intervals for each transect from 0-500 meters. We compared our collections to those made in similar locations throughout Lake Tahoe in 1962 and 1963.

Lakewide-weighted total benthic invertebrate density has declined 87% since the 1960s. Oligochaeta was the most common taxon observed in our samples. Lakewide-weighted oligochaete density has declined 79% since the 1960s. Chironomidae was the second most abundant taxa collected and its density has declined 65% since the 1960s. Two unique endemic taxa, the endemic stonefly Capnia lacustra and the blind amphipod Stygobromus, are still present in the lake, but their densities have declined dramatically since the 1960s (98%, and 99%, respectively). Two mechanisms have been proposed to explain the loss of benthic secondary production in Lake Tahoe. Previous research suggests cultural eutrophication may disrupt benthic production; however, increasing numbers of introduced aquatic species (e.g. crayfish and Mysid shrimp) may be competing with or preying upon native invertebrates. The interplay of these mechanisms is discussed.

Technical Session Abstracts

Erosion Modeling in the Lake Tahoe Basin Using WEPP

March 16, 2010
1:00 p.m. – 2:40 p.m.
Room 141

The Development of a Site-Specific Tahoe Basin Erosion Interface
- William J. Elliot

Development & Assessment of the WEPP Model in the Tahoe Basin
- Erin Brooks

Nutrient & Sediment Loading Predictions for Prescribed Fire Using Optimized WEPP Model
- Drea Em Traeumer

Improving Erosion Modeling on Forest Roads in the Lake Tahoe Basin
- Randy Foltz

BMP-SA: A Tool for Planning Road Best Management Practices at a Watershed Scale
- James (Andy) Efta

The Development of a Site-Specific Tahoe Basin Erosion Interface

William J. Elliot*
David E. Hall

***Rocky Mountain Research Station, 1221 South Main, Moscow, Idaho 83843. (208) 883-2338, welliot@fs.fed.us**

Funding Sources: Southern Nevada Public Lands Management Act & USDA Forest Service Rocky Mountain Research Station

It is difficult and expensive to develop predictive tools that can address site-specific conditions using scientifically defensible methods and databases. To address this problem, the Water Erosion Prediction Project (WEPP) model was used as the prediction engine. Because WEPP is physically-based, the majority of the input is site-specific. Readily available Digital Elevation Models (DEMs) can be used to estimate slope length and steepness values. Local precipitation values can be obtained from the PRISM database, which has monthly precipitation values on a 4-km grid. Local temperatures can be estimated by adjusting monthly maximum and minimum air temperatures from nearby climate stations for differences in elevation. The textures of local soils are available in the Soil Survey. Local and nearby research results are being used to estimate rill and interrill erodibility and hydraulic conductivity for basin soils. The ground cover can be measured on site. An online interface was developed to aid users in accessing the climate, soil, and disturbance information. A prototype for such an interface was completed, and is currently undergoing further validation. Access to an easy to use interface can be used by watershed managers within the basin to evaluate the effects of different management strategies in forests, or treatment methods in any disturbed area. Techniques that minimize erosion can be selected or justified. As various treatments and strategies are compared, it will be possible to determine the most cost-effective way to minimize offsite watershed impacts from onsite disturbances.

Development & Assessment of the WEPP Model in the Tahoe Basin

Erin S. Brooks*
Jan Boll
Biological & Agricultural Engineering, University of Idaho

Shuhui Dun
Joan Q. Wu
Biological Systems Engineering, Washington State University

William J. Elliot
USDA–FS Rocky Mountain Research Station

***Department of Biological & Agricultural Engineering, University of Idaho, Moscow, Idaho 83844-2060. (208) 885-6562, ebrooks@uidaho.edu**

Funding Source: Southern Nevada Public Lands Management Act

There is a great need for scientifically defensible management tools to evaluate impacts of management practices on fine sediment loading to Lake Tahoe. The Water Erosion Prediction Project (WEPP) model is a process-based hydrology and erosion model that has the potential to be a valuable management tool in the basin. This presentation provides a summary of the development and assessment of WEPP in the Tahoe basin.

Tahoe-specific climate, soils, and management input database files were created using publicly available data. Innovative protocols were developed to capture variability in climate and canopy cover across the basin and baseflow algorithms were developed to allow direct prediction of streamflow from large watersheds. WEPP was applied to 5 upland watersheds in the Tahoe basin. The accuracy was assessed with simulated and observed snowmelt, streamflow, total sediment load, and fine sediment load.

Agreement between simulated and observed snowmelt and streamflow was very good on the western and southern side of the basin. Streamflow was over-predicted on eastern watersheds which appears to be linked to groundwater storage effects and does not affect erosion prediction. Although stream sediment transport was not simulated by the model, the timing, magnitude, and sources of upland sediment contributions match closely with observations.

WEPP is capable of representing the fundamental hydrology and erosion mechanics in the basin and has the potential to be a valuable management tool. Further development and hillslope-scale validation of the model for a broader range of management practices is recommended.

Nutrient & Sediment Loading Predictions for Prescribed Fire Using Optimized WEPP Model

Drea Em Traeumer

Em Hydrology, LLC, 1165 Hunter Lake Drive, Reno, Nevada 89509. drea.em@gmail.com, (775) 750-0472

Funding Source: Southern Nevada Public Lands Management Act

Forest uplands have been identified as sediment and nutrient sources to Lake Tahoe; however, specific loadings from prescribed fire are unknown. Further, there is limited knowledge about the spatial and temporal variability of soil hydrophobicity in the Lake Tahoe Basin, or its associated effects on runoff quality, quantity, and soil erosion. To fill these knowledge gaps, a two-year research project is currently in progress to: spatially and temporally optimize the WEPP model for undisturbed and pile burning conditions; apply the WEPP model to predict sediment loadings, dissolved nutrient loadings, and adsorbed nutrient loadings from pile burning at the hillslope- and subwatershed-scales; and identify pile burning thresholds at the hillslope-scale for the purpose of guiding managers in the design of future pile burning fuel reduction projects.

WEPP's most sensitive erodibility parameters are being optimized for undisturbed and pile burning conditions on volcanic and granitic soils through *in situ* measurements and rainfall/runoff simulations. Optimized WEPP is being applied during Phase I of the project to predict sediment loadings and adsorbed and dissolved nutrient loadings from pile burning at the hillslope-scale, and to perform a sensitivity analysis to identify pile burning thresholds at the hillslope-scale.

The Phase I Summary Report is in progress, and will be finalized in January 2010 in advance of the Tahoe Science Conference.

The Phase I Summary Report will present predicted sediment loadings and adsorbed and dissolved nutrient loadings from pile burning at the hillslope, and will present pile burning thresholds at the hillslope-scale for the purpose of guiding managers in the design of future pile burning fuel reduction projects.

Improving Erosion Modeling on Forest Roads in the Lake Tahoe Basin

Randy B. Foltz*

N.S. Wagenbrenner

William J. Elliot

***Rocky Mountain Research Station, 1221 South Main Street, Moscow, ID, 83843. rfoltz@fs.fed.us**

Lake Tahoe is renowned for its beauty and exceptionally clear water; however, scientists estimate that the continued increase in fine sediment and nutrient transport to the lake threatens to diminish this clarity. The Lake Tahoe Basin Management Unit plans to employ the WEPP: Road erosion model as a predictive tool for land planning in the basin. WEPP: Road allows users to quantify sediment production from road surfaces and assess the effectiveness of best management practices on those surfaces. The purpose of this study was to obtain estimates of hydrologic parameters for native surface roads comprised of soils derived from the two predominant parent materials in the Lake Tahoe basin.

Rainfall simulations were conducted on four unpaved roads to determine saturated hydraulic conductivity and interrill erodibility. Average measured saturated hydraulic conductivity and interrill erodibility were 16 mm hr-1 and 1.0 x 106 kg s-1 m-4, respectively. The roads measured in this study produced sustained and relatively high sediment concentrations throughout the simulation period, possibly due to water repellency.

This study is part of a larger effort to derive road-specific infiltration and sediment detachment parameters for forest roads across the intermountain west. Information gained from this larger suite of studies has provided an indication of the variability in erosion parameters among forest roads and revealed additional information regarding road treatments. Viewed in the context of this larger effort, results from the Tahoe Basin can be understood from the appropriate perspective and modeling tools can be further refined to better achieve management efforts.

BMP-SA: A Tool for Planning Road Best Management Practices at a Watershed Scale

James (Andy) Efta*
Woodam Chung
Department of Forest Management, College of Forestry and Conservation,
the University of Montana

Randy B. Foltz
William J. Elliot
Rocky Mountain Research Station, Moscow Forest Sciences Laboratory

Hakjun Rhee
Biological Systems Engineering, Washington State University

***Department of Forest Management, College of Forestry & Conservation, The University of Montana, 32 Campus Drive, Missoula, Montana 59812. (406) 243-4264, a_efta@yahoo.com**

Funding Source: Lake Tahoe Southern Nevada Public Lands Management Act

To minimize impact of forest operations and recreation traffic on erosion and sedimentation, road managers must implement site-specific BMPs on the road network. At the watershed scale, this task becomes exceedingly difficult when trying to simultaneously account for cost, periodic maintenance scheduling, and equipment transport concerns.

We created BMP-SA, a model which provides hydrologists, engineers, and planners an interface to assist in planning BMP implementation and maintenance. Predictions from WEPP: Road, an erosion modeling tool, were coupled with a heuristic solver within BMP-SA to develop solutions which minimized predicted sediment entering waterways. BMP-SA developed solutions based on (1) initial budget per period, (2) potential treatment options for problematic road segments (and their modeled effectiveness), and (3) proximity between treatments.

BMP-SA consists of a standalone executable program with four text file inputs and a user manual. The Glenbrook Creek watershed was used as a test site for BMP-SA. Model results were consistent across different budget levels and under multiple modeling scenarios. Of the 173 surveyed forest road segments, 38 segments were available to have BMPs installed. The best possible solution produced by BMP-SA yielded a substantial reduction in predicted sediment leaving the buffer over the course of a 20-year planning horizon.

In the Lake Tahoe Basin, water quality impairment is an important issue. This decision support tool provides an efficient means for managers to concurrently evaluate the effectiveness and cost of sediment-mitigation treatments at minimizing water-quality impairment in the Basin.

Technical Session Abstracts

Frameworks for Adaptive Management & Planning

March 16, 2010
1:00 p.m. – 2:40 p.m.
Room 106

An Adaptive Management System to Monitor the Status & Trend of Tahoe Basin Environmental & Socioeconomic Conditions
- Shane Romsos

Performance Measures to Quantify the Activity & Benefits of the Lake Tahoe Environmental Improvement Program
- Chad Praul

Lake Clarity Crediting Program: Linking Policy to Science
- Jeremy Sokulsky

BMP RAM Tool: Documenting & Tracking Treatment BMP Condition in Lake Tahoe
- Maggie Mathias

California Essential Habitat Connectivity Project: Implications for the Tahoe Basin
- Adam Lewandowski

An Adaptive Management System to Monitor the Status & Trend of Tahoe Basin Environmental & Socioeconomic Conditions

Shane Romsos*
Tahoe Regional Planning Agency

Chad Praul
Marcy Protteau
Environmental Incentives

*** Tahoe Regional Planning Agency, 128 Market Street, Stateline, Nevada. (775) 589-5201, sromsos@trpa.org**

Funding Source: Southern Nevada Public Lands Management Act

Questions about the benefits of Tahoe Basin restoration efforts can be numerically answered through two sets of measures: 1) performance measures that describe how much output has been generated through the actions of the EIP and 2) indicators of environmental and socioeconomic conditions that reflect the desired outcomes of actions taken. Development of this adaptive management system focused on enhancing a program to cooperatively, cost-effectively and reliably monitor and report indicators of environmental and socioeconomic conditions in the Tahoe Basin. The program has developed much of the infrastructure needed to produce an annual conditions report and make well-informed management decisions. Infrastructure includes desired condition-based conceptual models, monitoring plan guidance, a structured process to incorporate monitoring findings into decisions, an organizational and governance structure, and a web-based collaboration system. Demonstration of this infrastructure has allowed the effort to engage the TRPA, LTBMU, Lahontan Water Board and NDEP as programmatic partners who will contribute data and staff resources to produce an annual conditions report and use this information in management decisions. This program improves the way that the TRPA's thresholds and the LTBMU's desired conditions are reported by 1) enhancing the consistency, and timeliness of data collection, and 2) focusing on reporting that makes the information accessible to decisionmaking audiences. The program will strengthen the need for strong science through developing monitoring plans, setting indicator targets and benchmarks, and developing conceptual models applicable to the management audience.

Performance Measures to Quantify the Activity & Benefits of the Lake Tahoe Environmental Improvement Program

Chad Praul*
Marcy Protteau
Environmental Incentives

Paul Nielsen
Tahoe Regional Planning Agency

***Environmental Incentives, 1027 Emerald Bay Road, South Lake Tahoe, California 96150. (530) 318-4540, cpraul@enviroincentives.com**

Funding Source: US Environmental Protection Agency

The public and political supporters of the Lake Tahoe Environmental Improvement Program (EIP) have invested more than a billion dollars in Lake Tahoe since the 1997 Presidential Summit. These investors have requested quantitative answers to the question "What has been done with our support?" This question can be answered through two sets of measures: 1) performance measures that track the actions of the EIP and 2) indicators of environmental and socioeconomic conditions that may be affected by the actions taken. This project focused on development of the performance measures aspect of the EIP. The project approach involved rating candidate performance measures in areas of rapid reportability, acceptable cost, closeness of relationship to environmental goals (e.g. TRPA Thresholds) and understandability to the target audience. Candidate performance measures were also rated on reporting need by representatives of major EIP partners. This information was used to inform a series of discussions in which a manageable set of performance measures were vetted through EIP partner agency management and executives. Results of this effort include agreement by EIP executives on a manageable set of roughly 40 performance measures. Brief protocols are being developed for each performance measure that describe what counts as a unit of performance and how information should be reported. This manageable set of performance measures will strengthen our ability to rapidly and comprehensively report on EIP actions using consistent and comparable figures that can build confidence among the EIPs political and public supporters.

Lake Clarity Crediting Program: Linking Policy to Science

Jeremy Sokulsky*
Environmental Incentives

John Reuter, Ph.D.
Tahoe Environmental Research Center,
University of California, Davis

***Environmental Incentives, 1027 Emerald Bay Road, South Lake Tahoe, California 96150. (530) 541-2980, jsokulsky@enviroincentives.com**

Funding Source: US Environmental Protection Agency Targeted Watershed Initiative Grant

Since 2001 dozens of scientific investigations have focused monitoring, modeling and research to inform the development of the Lake Tahoe Total Maximum Daily Load (TMDL). The findings of this body of work improved the understanding of how to restore Lake Tahoe clarity and produced useful tools to support targeted implementation of pollutant controls. However, regulatory policy did not address the primary pollutant of concern and did not recognize the benefits of prioritizing efforts that would have the largest net load reduction of pollutants of concern.

The Lake Clarity Crediting Program (Crediting Program) links scientific findings to policy in a manner that motivates effective actions to improve Lake Tahoe clarity. The Crediting Program was developed for the Lahontan Regional Water Quality Control Board and the Nevada Division of Environmental Protection. The multi-year effort to develop the Crediting Program involved reviewing existing science, policy and pollutant control practices, and engaging policy-makers, scientists and stormwater managers. The Lake Clarity Crediting Program Handbook was released in September of 2009. It defines a Lake Clarity Credit and specific processes that comprise an accounting system to track progress toward meeting pollutant load reduction milestones and restoring lake clarity. The ongoing assessment and reporting requirements provide a platform to leverage monitoring and research findings through the periodic update of tools and protocols. The Handbook defines how the Crediting Program and associated policies formally adapt to new scientific information.

BMP RAM Tool: Documenting & Tracking Treatment BMP Condition in Lake Tahoe

Maggie Mathias*
Nicole Beck, , Ph.D.
Brent Wolfe
Northwest Hydraulic Consultants

Chad Praul
Environmental Incentives

***2NDNATURE, 321 Frederick Street, Santa Cruz, California 95062. (831) 426-9119, maggie@2ndnaturellc.com**

Funder: BMP RAM v1. US Army Corps of Engineers

Many Treatment BMPs are constructed in Lake Tahoe and then continued maintenance to maintain water quality treatment performance is minimal and inconsistent. The Best Management Practices Maintenance Rapid Assessment Methodology (BMP RAM) is a simple and repeatable field observation and data management tool that can assist Lake Tahoe natural resource managers in determining the relative condition of urban stormwater Treatment BMPs. The primary purpose of the BMP RAM is to inform the user of the relative urgency of water quality maintenance for Treatment BMPs. The BMP RAM provides a practical, consistent and reliable tool to track the condition of a particular Treatment BMP, relative to its observed condition at time of installation or immediately following complete maintenance.

The BMP RAM is a recommended stormwater tool by the Lake Tahoe Clarity Program for use by local jurisdictions to validate that the condition of Treatment BMPs that are included in a catchment registration are acceptably maintained and thus provide consistent load reductions of the pollutants of concern. Treatment BMP condition is based on the results of rapid field observations that serve as reliable proxies for the treatment processes relied upon by a distinct BMP Type. The treatment processes include infiltration, particle capture, nutrient cycling and/or media filtration. The BMP RAM consists of six distinct STEPs implemented by the user, each of which required data collection, database population and decision making. Version 1 of the BMP RAM consists of a Technical Report, Users Manual and custom Database available for download from: http://www.swrcb.ca.gov/lahontan/water_issues/programs/tmdl/lake_tahoe/index.shtml

California Essential Habitat Connectivity Project: Implications for the Tahoe Basin

A. Lewandowski*
California Tahoe Conservancy

P. Beier
Northern Arizona University

J. Strittholt
W. Spencer
Conservation Biology Institute

K. Winters
Dangermond Group

K. Penrod
SC Wildlands

A. Pettler
CalTrans

M. Parisi
CDFG

***California Tahoe Conservancy, 1061 Third Street, South Lake Tahoe, California 96150. (530) 543-6054, alewandoski@tahoe.ca.gov**

Funding Source: CalTrans and California Department of Fish & Game

Connected habitats are integral to biodiversity conservation because they allow species to adapt to climate change, preserve meta-population dynamics, and increase the viability of species with large area requirements. Yet, habitat fragmentation rapidly continues, largely due to a scarcity of information on areas providing essential connectivity at landscape and regional scales. The California Essential Habitat Connectivity Project was initiated to identify high priority areas contributing to the connectivity of habitats across California and into neighboring states. We identified relatively intact natural landscape blocks using statewide data on ecological condition, protection status, and biological value. We then developed a set of rules derived from graph theory to determine which landscape blocks to connect. To delineate connectivity areas we performed least-cost corridor modeling using a raster based on land cover and protection status. The result was 172 modeled corridors, placeholders for potential corridors across state lines, and a strategic plan for adapting this approach to regional scales. We will present results from the statewide analysis with an emphasis on corridors in and around the Tahoe Basin. We will discuss approaches to modify the statewide methods to identify regionally significant corridors at the Tahoe Basin scale. Modeled corridors from the statewide effort and potential future analysis at the Tahoe Basin scale can be used to prioritize restoration and acquisition of lands, and provide site-specific information to enhance the effectiveness of current state and TRPA regulations regarding the protection of wildlife movement corridors.

Technical Session Abstracts

Invasive Species in the Nearshore

March 16, 2010
3:00 p.m. – 4:40 p.m.
Room 139

Crayfish Distribution & Abundance in Lake Tahoe, USA
- John Umek

Invasive Aquatic Plants in Lake Tahoe:
Where Are They & Why Are They Continuing to Spread?
- Lars W.J. Anderson

Evaluating the Effectiveness of Eurasian Watermilfoil (*Myriophillum Spicatum*) Control Efforts in Emerald Bay, Lake Tahoe, California
- Zachary Hymanson

Predicting Establishment & Predation Impact of Non-Native Largemouth Bass in a Large, Sub-Alpine, Oligotrophic Lake
- Sudeep Chandra

Where Are They Going?
Movement of Non-Native Warmwater Fishes in Lake Tahoe
- Christine Ngai

Crayfish Distribution & Abundance in Lake Tahoe, USA

John Umek*
Sudeep Chandra, Ph.D.
Andrea Caires
Christine Ngai
Joe Sullivan

***University of Nevada, Reno, Department of Natural Resources & Environmental Sciences, 1000 Valley Road, Reno, Nevada 89512. (775) 784-7514, umekj@unr.nevada.edu**

Invasive species have become an increasing problem in the United States. In the Western United States for example, nonnative crayfish are of increasing concern to managers since they compete or prey on native biodiversity and alter ecosystem function. Once they invade, crayfish can dominate freshwater ecosystems with strong effects on native littoral habitats and biota through foraging, regulating the flow of energy and nutrients through the system and therefore can have both a direct and indirect effect on trophic interactions. Benthic invertebrate surveys carried out in 2008 found acute declines in the benthic community that may be attributed to crayfish (*Pacifasticus leniusculus*) in Lake Tahoe. To determine the present crayfish abundance and distribution, minnow traps were set at 14 locations around the lake at 6 depths in the littoral zone for at least a 12 hr period during the summers of 2007 and 2008. Exclusion and laboratory experiments were also carried out to determine if this species control benthic algae and invertebrate dynamics.

Preliminary data indicates that the crayfish population is increasing in Lake Tahoe. Data collected also shows an increase in crayfish abundance at deeper depths than previously found. Exclusion as well as laboratory and field observations suggest crayfish in large lake ecosystems control benthic ecosystem dynamics. Depending on the extent of the control, policy makers should be able to develop mechanisms to control and manage this species and allow for invertebrate communities to recover. Future research should focus on understanding the life-history and mechanisms controlling this species if they are to be controlled in Lake Tahoe or other large lakes.

Invasive Aquatic Plants in Lake Tahoe: Where Are They & Why Are They Continuing to Spread?

Lars W.J. Anderson

USDA-Agricultural Research Service, One Shields Avenue, Mail Stop #4, Davis, California, 95616.
(530) 752-7870, lwanderson@ucdavis.edu

The last Lake Tahoe survey for aquatic plants in 2006 showed that Eurasian watermilfoil and curlyleaf pondweed had spread since 1995. Tahoe Keys surveys in 2008 and 2009 showed that curlyleaf pondweed was in 32% of 315 samples. Eurasian watermilfoil expanded from 9 sites in 1995 to 17 sites in 2009. Walters (2000) found that sediment nutrient levels alone could not explain absence of Eurasian watermilfoil in some areas, but that physical conditions, such as wave exposure and substrate type appeared to limit establishment. Thus, new infestations along the protected, western shore are not surprising since the main sources of propagules have not been reduced by current management practices. Expansion of curlyleaf pondweed along the southern to eastern shores suggests that near-shore, eastward flowing currents are driving the spread via turions and turion-ladden plant fragments. Eurasian watermilfoil movement may be more directly associated with boating activity, as well as its ability to re-establish from very short fragments. The distribution and abundance of both invasive plants, coupled with their historic and well-documented dominance over native plants in cold-water lake systems, strongly suggests that it is only a matter of time before more of Lake Tahoe's vulnerable shoreline will be infested with one or both species. This can only be stopped by a fully integrated, well-coordinated, whole lake eradication program. The sooner this approach is implemented, the more likely it is to succeed, resulting in lower over all management cost in the long term and protection of the fragile littoral habitat.

Evaluating the Effectiveness of Eurasian Watermilfoil (*Myriophillum Spicatum*) Control Efforts in Emerald Bay, Lake Tahoe, California

Zachary P. Hymanson*
Tahoe Science Consortium

Tamara Sasaki
California Department of Parks and Recreation

***291 Country Club Drive, Incline Village, Nevada 89451. (775) 881-7561, redfir@sbcglobal.net**

Funding Source: California Department of Parks & Recreation

Emerald Bay is a unique and important natural feature of Lake Tahoe and considerable resources are expended to conserve and protect it from a variety of threats, including invasive species. Unfortunately, the aquatic invasive plant Eurasian watermilfoil (EWM) is now well established in three distinct patches at the western end of Emerald Bay.

Light-excluding barriers were used to reduce the abundance of EWM at two locations in Emerald Bay between 2007 and 2009. Barriers (100 ft^2) were placed over EWM for ~6 weeks. Qualitative observations after barrier removal showed the plants underneath were killed, suggesting this may be a cost-effective, low-impact strategy for EWM control. The purpose of this study was to quantify these observations and to determine how the barrier control efforts performed over time through repeated sampling of EWM plant height and density.

Measurements of plant density in non-treated areas show the EWM patches in Emerald Bay are well established, although plant density has declined somewhat over time in all three patches for unknown reasons. In contrast, plant density in the treated area showed a modest but increasing trend over time. Results show EWM will begin to recolonize treatment sites within the first year. Plant height within the non-treated areas did not show a consistent trend over time. Plant density and plant height are not strongly related, and we cannot use plant height as a proxy for plant density. Overall, the use of barriers alone is unlikely to provide an effective strategy for controlling EWM in Emerald Bay.

Predicting Establishment & Predation Impact of Non-Native Largemouth Bass in a Large, Sub-Alpine, Oligotrophic Lake

Sudeep Chandra*, Ph.D.
Marcy Kamerath
Christine Kai Lai Ngai
Department of Natural Resources and Environmental Science

Todd Steissberg
Brant Allen
Tahoe Environmental Research Center

***University of Nevada, Reno, 1000 Valley Road, Mail Stop 186, Reno, Nevada 89512. (775) 784-6221, sudeep@cabnr.unr.edu**

Invasive largemouth bass is examined prior to its widespread establishment in Lake Tahoe. While the Tahoe Keys is a major source population, colonization of the entire lake however can take several years and is promoted through the warming of the Lake and modification through the introduction of other invasive species such as plants. Establishment likelihood and impact of invasive largemouth bass in a Lake Tahoe was identified by a model comprised of two data layers (nearshore temperature and distribution of preferred habitat structure) at ~2 km resolution. Nearshore temperatures revealed the entire nearshore is thermally suitable for bass spawning, and that current and future bass establishment is likely limited by the distribution of aquatic vegetation. Bass presence observed in 2006 snorkel surveys occurred at a frequency that matched the ranks identified by the establishment likelihood model. Bioenergetics models derived consumption estimates of minimum and maximum bass densities that ranged from 0.96 to 24.08 kg for the model period. Bass consumption compared to nearshore fish biomass estimated from snorkel surveys indicated bass could eliminate 100 % of fish biomass at 37 % to 80 % of sites examined. This is the first study in Lake Tahoe to predict the future distribution and impact of invasive species in Lake Tahoe. Similar approached could be adopted to assist management in determining areas for control and management. This project was funded by the US Forest Service: Lake Tahoe Basin Management Unit and the Nevada Division of State Lands.

Where Are They Going?
Movement of Non-Native Warmwater Fishes in Lake Tahoe

Christine Ka Lai Ngai*
Sudeep Chandra, Ph.D.
Department of Natural Resources and Environmental Science,
University of Nevada, Reno

Brant Allen
Department of Environmental Science & Policy,
University of California, Davis

*** Department of Natural Resources & Environmental Science, University of Nevada, Reno, 1000 Valley Road, Mail Stop 186, Reno, Nevada 89512. (775) 881-7570, cngai@cabnr.unr.edu**

Funding source: US Forest Service Lake Tahoe Basin Management Unit, Nevada Division of State Lands License Plate Fund, The Nature Fund grant by Tahoe Truckee Community Foundation, California Department of Fish & Game

Nonnative species introductions and their establishments within Lake Tahoe are of growing concern due to their potential economic and ecological impacts. In recent years, small satellite populations of nonnative warmwater fishes (e.g. largemouth bass *Micropterus salmoides* and bluegill *Lepomis macrochirus*) have appeared around the lake. We believe that these populations were likely sourced from a more established population in the Tahoe Keys. Lake-wide establishment of these nonnative predators can significantly impact the native biota of Lake Tahoe.

We employed hydroacoustic telemetry technology 1) to monitor the movement of nonnative fishes within east Tahoe Keys and between the marina and the lake proper, and 2) to determine if this established population may be the source population for other satellite populations within the lake. Fourteen largemouth bass and seven bluegill were tracked between May to December in 2008. Most of the tagged fish departed the marina at least once and returned to the marina in late summer. However, three bass and two bluegill appeared to have immigrated to the lake as they were not detected by any of the acoustic receivers in the marina following their lakeward movement. Data suggest that their movements may be related to changes in water temperature.

This study suggests that nonnative warmwater fishes are potentially leaving the marinas and move to other parts of the lake given suitable conditions. Therefore, in order to prevent and control lakewide proliferation of these warmwater fishes, management efforts should be focused on the containment and reduction of these marinas populations.

Technical Session Abstracts

Soil Disturbance & Erosion

March 16, 2010
3:00 p.m. – 4:40 p.m.
Room 141

Microbial Community Composition & Stability
of Disturbed Soils in the Lake Tahoe Basin
- Mark Grismer & Ann Collins

Developing Fuels Treatments for Balancing Fuel Reduction,
Soil Exposure & Potential for Erosion in the Tahoe Basin
- Andrew Stubblefield

Soil Water Repellency Effects on Infiltration
& Erosion Rates in the Tahoe Basin
- Mark Grismer & Erin Rice

Modeling & Real-Time Measurements:
Function, Constraints, Opportunities
- Mike Hogan

Erosion Modeling for Land Management
in the Tahoe Basin — Soil Restoration Thresholds
- Mark Grismer

Microbial Community Composition & Stability of Disturbed Soils in the Lake Tahoe Basin

Mark E. Grismer*
A. B. Collins

***Soils & Biogeochemistry Graduate Group, University of California, Davis, 1 Shields Avenue, Davis, California 95616. (530) 304-5797, megrismer@ucdavis.edu**

While the influence of soil physical and chemical characteristics on erodibility have been examined on disturbed soils across the Tahoe Basin, the soil microbiological component remains poorly understood. We assessed the type of microbial groups and their influence of on soil stability/erodibility using rainfall simulation and microbial lipid analysis. We also consider the relative success of these restoration treatments, not only in terms of hydrologic parameters, but also as a function of microbial community structure. Study sites included roadcuts and skiruns having parent material of either granitic or volcanic origin. Treatment plots at each site contained a combination of soil loosening and erosion control amendments. Phospholipid Fatty Acid Analysis (PLFA) was conducted on samples from all plots to determine total microbial biomass, bacteria, gram-negative bacteria, gram-positive bacteria, actinomycetes, fungi, AM fungi, and stress indicator biomarkers and used as "fingerprints" or ecological indicators. Microbial communities differed by treatment. Compost treatment sites generally contained the most bacteria, actinomycetes and AM fungi, and the least fungi. Native sites contained the most fungi and the least AM fungi. The occurrence of runoff was found to be related to greater levels of gram-negative bacteria and mono-unsaturated: saturated lipids at all locations. Increased infiltration rates were associated with increased total microbial biomass, and on roadcuts were specifically associated with fungal biomass. Using PLFA and multivariate statistical methods, Centroid plots, expressed in two-dimensional space, were developed to graphically illustrate relative similarity of microbial community structures. The results showed that PLFA fingerprints differed from location to location, but at all locations native plots were significantly different than treated plots, and furthermore, that all treated plots were more similar to one another than to native plots.

Developing Fuels Treatments for Balancing Fuel Reduction, Soil Exposure & Potential for Erosion in the Tahoe Basin

Andrew P. Stubblefield*
Erin Banwell
J. Morgan Varner
Department of Forestry and Wildland Resources, Humboldt State University

Eric E. Knapp
US Forest Service, Pacific Southwest Research Station

***Watershed Management, Humboldt State University, One Harpst Street, Arcata, California.**
(715) 902-0053, nickharrison8105@yahoo.com

Funding source: Southern Nevada Public Lands Management Act

Efforts to minimize wildfire hazard and efforts to prevent erosion can conflict with each other within the Tahoe Basin. Management activities that reduce erosion such as maintaining continuous surface litter and duff layer, or minimizing forest thinning activities on steep slopes, can lead to increased wildfire hazard. Wildfire, ironically, has the potential to dramatically increase watershed erosion rates. This study aims to develop forest fuels management practices that minimize fire hazard while maintaining sufficient soil cover to trap eroded sediment. Runoff simulation on 2x5 meter plots will be performed at 8 masticated sites and 8 prescribed fire sites within the Tahoe Basin. Within each site, 9 treatments will be performed, varying the thickness and spatial distribution of forest litter or masticated material. Water is applied to the plots and all runoff collected. In the first field season we sampled 6 masticated sites. Results indicated that 25% cover with masticated materials was sufficient to trap 90-100% of sediment eroding from the remainder of the plot (75% or 7.5 m^2) that is bare soil. This result would support the practice of leaving patches of bare ground to slow wildfire spread. The second aspect of the experiment was to vary the depth of masticated fuels. At 2 of 6 sites a strong negative correlation was found between fuel depth and erosion. The remaining sites showed full erosion protection even with only 25% of the original fuel depths. Ongoing work will evaluate linkages between fuel moisture, burn patchiness, and erosion.

Soil Water Repellency Effects on Infiltration & Erosion Rates in the Tahoe Basin

M. E. Grismer*
E. C. Rice

*** Department of LAWR-Hydrology, University of California, Davis, 1 Shields Ave., Davis, California 95616. (530) 304-5797, egrismer@ucdavis.edu**

Though often critical towards estimation of runoff and erosion rates, knowledge of soil-water repellency remains over-generalized or anecdotal because few studies isolate and quantify repellency effects. Repellency, or hydrophobicity arises in the late-summer season, or following fire events. Here, we employ the rainfall simulator (RS) used in several previous studies, but now with a surfactant solution to investigate the effects of repellency at relatively undisturbed "native" forested soil sites on slopes of 10-15%. These RSs (120 mm hr^{-1}) were conducted on 0.64 m^2 plots and compared with the often, more simply used Mini-Disk Infiltrometer (MDI) measurements of infiltration rates. We compare these results to those obtained from previous RS tests on granitic soils immediately following the Angora fire on slopes of 16-22%. The effects of repellency on infiltration were evident as all plots with untreated water produced runoff, while only 2 of 12 plots treated with surfactant had runoff. At the volcanic soil sites, MDI measured infiltration rates using surfactant exceeded those with water by 20% when there was little litter cover, and by factors of 3 with substantial litter cover. Similarly, at the granitic soil sites, surfactant-enhanced MDI infiltration rates were 4 times greater with little litter, and 8 times greater with substantial litter cover. Similar erosion rates were obtained at the Angora fire site where RS infiltration rates varied from 40-70 mm hr^{-1} and sediment yields were 19.3, 3.78, 1.34 and 0.39 g mm^{-1} m^{-2}, respectively, for bare, burnt brush, straw and pine needle mulch covered soils. Runoff particle-sizes also decreased with increasing cover thickness and OM content; the D_{10} sizes were 8.2, 12, 12.7 and 13.6 μm, respectively. Dry season and fire-induced hydrophobicity appear to have substantial effects on plot-scale infiltration and erosion rates at several Basin sites.

Linking Regulations, Implementation & Management Through Science & Monitoring

Michael Hogan*
Integrated Environmental Restoration Services

Mark Grismer
Hydrologic Sciences, University of California, Davis

***Integrated Environmental Restoration Services, 2780 Lake Forest Road, Tahoe City, CA, 96145. (530)581-0355, mhogan@ierstahoe.com**

Considerable effort has been applied to addressing anthropogenic ecosystem impacts in the Lake Tahoe Basin. Research, monitoring, erosion control and restoration efforts and regulations have all been implemented with the intended outcome of improving watershed conditions thereby reducing loading to the Lake. However, there has been ongoing debate as to the relative "success" of these efforts. While some have certainly resulted in tangible improvement, others have unknown outcomes. Discussions of this range of outcomes have often centered on the interaction of three elements; Policy, Science/Monitoring and Management, all to a degree affected by environmental advocacy groups in the Basin. This presentation will identify and discuss how each of these elements possibly function in the Basin, especially as they relate to each other. For instance, management will occur as long as there is some directive or need to manage and as long as funding is directed toward that management. Policy will tend to direct that management but the efficacy of the policy influence will depend on how well the policy is formulated and how effectively it is translated into management language. Further, policy will be effective as a management directive to the extent that it is based on good, clear and useful science and that the science is directly related to management activities. Monitoring, when linked to robust field-based science, also plays a critical role throughout the management-policy-science trinity and in fact, may be the integrator of those three elements, when designed and applied efficiently and correctly. This presentation will discuss these three elements and their interaction through a brief overview and suggestions for how to better engage each element with each other, based on actual projects and processes. We will suggest possible methods and areas of cooperation and collaboration that might maximize environmental improvement.

Erosion Modeling for Land Management in the Tahoe Basin – Soil Restoration Thresholds

Mark E. Grismer

Department of LAWR-Hydrology, University of California, Davis, 1 Shields Avenue, Davis, California 95616. (530) 304-5797, megrismer@ucdavis.edu

How forest management effects water quality is a principle concern in the sub-alpine Tahoe Basin and elsewhere as regulatory agencies work to determine which restoration or management practices actually lower (and by how much) sediment, fine particles and/or nutrient loadings to the Lake, or impacted streams. There are few assessments of how forest practices and other restoration changes within a watershed presumably decrease discharged sediment, fines or nutrient loads. Nor, have there been quantitative assessments or evaluations at either local or watershed scales to determine if such changes actually result in decreased loads. A local-scale, field-data based runoff and erosion model for three Lake west-shore watersheds [Quail, Homewood (HMR) and Madden Creeks], daily runoff and sediment loading from surface runoff and channel erosion was developed. Based on field determination of infiltration, runoff and erosion characteristics of a wide range of soil conditions in the Basin developed from ~1000 rainfall simulation plots, this model is used to determine the effects of possible soil restoration (e.g. dirt road removal, rehabilitating skiruns, forest fuels reduction management) towards sediment and fines load reductions in the HMR watershed and to assess what fractional area treated and/or soil function restored is required to obtain a measurable reduction in sediment loads given the hydrologic variability of the 1994-2005 period. For example, substantial dirt road restoration (50% by area), while reducing mean daily sediment loading by 12-30 kg/day for average daily flows of 3.5 to 28.4 cfs, is such a reduction that can only be assessed with ~78% confidence using the entire 11-year record of flows greater than 20 cfs. Suggestions for minimum water quality monitoring to detect changes in sediment loading presumably associated with land management activities are also developed so as to guide monitoring efforts towards evaluation of TMDL “crediting” for load reduction efforts.

Technical Session Abstracts

Stream & Habitat Restoration

March 16, 2010
3:00 p.m. – 4:40 p.m.
Room 106

Riparian Ecosystem Restoration & Effectiveness Framework
- Brian Spear

Numerical Modeling of the Influences of Floodplain Morphology & Vegetation on Sediment Retention in Trout Creek
- Stephen Andrews

Biological Monitoring of the Trout Creek Channel Reconstruction Restoration
- David B. Herbst

What, Where, How, When:
Developing a Restoration RX for Tahoe Yellow Cress
- Alison Stanton

Predictive Modeling of Cheatgrass Invasion Risk for the Lake Tahoe Basin
- Samuel Veloz

Riparian Ecosystem Restoration & Effectiveness Framework

Brian Spear*
Nicole Beck, Ph.D
2NDNATURE, LLC

Matt Kiesse
River Run Consulting

Chad Praul
Environmental Incentives

***2NDNATURE, 321 Frederick Street, Santa Cruz, California 95062. (831) 426-9119, brian@2ndnaturellc.com**

Funding Source: USFS Southern Nevada Public Lands Management Act Research Grant

A preliminary inventory of available documentation and effectiveness reports on riparian ecosystem restoration projects (winter 2009) led to the conclusion that the documentation of a clear process and format would greatly benefit the future development of riparian restoration effectiveness evaluations. The 2NDNATURE team developed a recommended Riparian Ecosystem Restoration broad goal statement and conceptual model to focus the Lake Tahoe Basin-wide discussions. The Riparian Ecosystem Restoration and Effectiveness Framework (Framework) was developed to focus the process and improve the communications when stream restoration practitioners are implementing specific stream restoration projects. The Framework process is expected to simplify the summary of existing (impaired conditions), the development of testable restoration project objectives, and improve the quality of restoration project monitoring strategies. The final document contains a number of specific recommendations and guidelines on how to improve the quality of protocol and metric selection, analysis and reporting to increase the confidence in effectiveness monitoring results. The Framework development for future riparian restoration projects can build upon a number of the attributes, metrics and protocols recommended in the tangible example developed by the 2NDNATURE team. The final products of the Framework include an Existing Conditions (pre-restoration) Summary, Project Objectives, Monitoring Strategy and an Adaptive Management Plan. These products will increase the consistency of the documentation of the restoration team intentions to interested parties many years following the completion of the restoration actions, thereby directly improving the availability and quality of the data and information available to make long-term adaptive management decisions.

Numerical Modeling of the Influences of Floodplain Morphology & Vegetation on Sediment Retention in Trout Creek

Stephen Andrews*
S. Geoffrey Schladow

***Tahoe Environmental Research Center, Department of Civil & Environmental Engineering, University of California, Davis. (530) 220-5697, swandrews@ucdavis.edu**

Funding Sources: Southern Nevada Public Lands Management Act; California Tahoe Conservancy; University of California, Davis

Stream inflows are the largest within-basin source of fine sediment and nutrients to Lake Tahoe. Of the 63 streams entering the lake, the Upper Truckee River and Trout Creek are 2 of the top 3 contributors because of their large watershed area and highly urbanized watersheds. Several floodplain restoration projects are in the planning or implementation stages in these watersheds because: a) much functional floodplain land has been lost due to development and river channelization, b) floodplains have natural removal mechanisms that can substantially reduce suspended sediment and nutrient fluxes during high flow, and c) floodplain restoration is relatively inexpensive compared to traditional treatment techniques and provides additional ecosystem and recreational benefits. In this study, we evaluate the effect of restored floodplain design on suspended sediment retention. A two-dimensional hydrodynamic-water quality model is used to examine the effect of the placement of medium-scale topographic features (such as retention ponds, berms, and weirs) and vegetation patches in order to achieve increased retention of fine suspended sediment. Results are analyzed using predicted spatial patterns of sediment deposition and overall removal efficiencies. Floodplain morphology changes are shown to have a greater influence on sediment retention than vegetation changes. Both factors varied in effectiveness depending on the magnitude of the flood. This study provides an important tool in future planning and design of floodplain restoration efforts in the Tahoe basin and the Sierra.

Biological Monitoring of the Trout Creek Channel Reconstruction Restoration

David B. Herbst

Sierra Nevada Aquatic Research Laboratory, University of California, HCR 79 Box 198, Mammoth Lakes, California 93546. (760) 935-4380, herbst@lifesci.ucsb.edu

Channelization of a portion of Trout Creek, tributary to the Upper Truckee River, had produced an incised and eroded bed, sediment deposition, and degraded aquatic and riparian habitat conditions. As part of efforts to stabilize this stream and control sediment delivery to Lake Tahoe, sections were rebuilt to restore natural channel sinuosity, pool-riffle sequences, substrate composition, and bank stability and reestablish hydrologic function. Bioassessment monitoring of the stream invertebrate community before and after the project was used to evaluate the ecological success of channel reconstruction. Initial post-project data indicated habitat quality objectives were achieved and there was greater capacity to support biological diversity.

Recent biomonitoring data show that composite indicators of diversity and size structure of the instream community have declined from the initial post-restoration gains. While stream health appears to have diminished, the biological community is in a state of flux, and has not simply returned to the pre-restoration state. This may reflect ongoing adjustments of the channel to flows and sediment flux that has brought sand and fine particles back into riffle habitats. Whether these ongoing erosion and depositional processes reach some steady state, the presence of coarse rock substrates will continue to be integral to supporting diverse benthic invertebrate life. Available data indicate that the efforts to date have not yet completely restored a healthy stream environment but that integrated ecological, hydrological and geomorphic studies are needed to assess how the physical environment and flow regime interact with ecological structure and function.

What, Where, How, When: Developing a Restoration RX for Tahoe Yellow Cress

Alison Stanton*
Bruce Pavlik

***BMP Ecosciences, 2520 Lake Tahoe Boulevard, Suite # 8, South Lake Tahoe, California 96150.**
(530) 544-1869, alisonestanton@sbcglobal.net

Funding sources: Southern Nevada Public Lands Management Act capital grant from the USDA Forest Service, Section 6 funds from the US Fish & Wildlife Service and the California Department of Fish & Game, and US Bureau of Reclamation.

Tahoe yellow cress (TYC, *Rorippa subumbellata* Roll.) is a low-growing, herbaceous perennial plant endemic to the shores of Lake Tahoe. The species has been a candidate for protection under the Endangered Species Act since 1999.

The TYC Conservation Strategy provides the basic framework for recovery, designed to preclude listing under ESA. A collaboratively designed research program addresses a specific set of Key Management Questions. Results from experimental plantings of over 9,000 container-grown plants at 14 sites around Lake Tahoe from 2003 to 2006 have identified the what, where, and how of TYC restoration including the plant characteristics (what), habitat conditions (where), and propagation techniques and logistical factors (how) that influence restoration success. Several key questions remained unanswered including; 1) when is the optimal time to conduct outplantings of container-grown TYC? and 2) Is it possible to translocate (i.e move naturally occurring TYC) both within and among sites?

Results from field experiments in 2008 and 2009 indicate that while planting time did not strongly influence overall survivorship, the June cohort was significantly more likely to reproduce than Aug/Sept plants. For planting method, first year survivorship and reproduction of container-grown and translocated plants was very similar. Although translocation is a potentially controversial it can be considered part of the restoration toolbox for TYC. However, in the second year, plant canopy size and therefore seed output of container-grown plants was significantly greater than translocants in optimal habitat. These new results will be presented along with part research as the supporting body of evidence for a decision tree model that guides users toward restoration prescriptions and best management practices for a wide range of project- or site-specific conditions.

Predictive Modeling of Cheatgrass Invasion Risk for the Lake Tahoe Basin

Samuel Veloz*
Brian Anacker
University of California, Davis,
Department of Environmental Science and Policy

Hugh Safford
USDA Forest Service, Pacific Southwest Region

***University of California, Davis, Department of Environmental Science & Policy, One Shields Avenue, Davis, California 95616, sveloz@ucdavis.edu**

Cheatgrass (*Bromus tectorum*) is an exotic species of major concern that is increasingly detected in Sierran meadows. To investigate the risk of cheatgrass invasion in the Lake Tahoe Basin (LTB), we developed a spatially explicit model of invasion risk based on the climatic niche of cheatgrass. This model was used to predict which areas within the LTB contain climactically suitable conditions for cheatgrass invasion. We used this model to forecast future invasion risk using simulations of future climate based on 15 different scenarios of climate change.

The model of the current distribution of cheatgrass within the basin accurately discriminates presence sites from absence sites 92% of the time. Many large areas at lower elevations along the east and south shores, corresponding to drier areas, were predicted to be highly suitable. A second model based solely on disturbance or dispersal variables indicated that establishment of cheatgrass in some climatically suitable areas may be limited by dispersal and/or disturbance. In these high-risk areas, steps to prevent both the introduction of cheatgrass seed and the disturbance of native vegetation should be taken. Future climate scenarios result in a predicted increase in average climatic suitability for cheatgrass invasion throughout the basin. The results indicate that future management activities will influence the establishment of cheatgrass within the LTB and that consideration of the risks to invasion will become increasingly important if temperatures increase as predicted by climate change models.

Technical Session Abstracts

Biological Dimensions of Tahoe Water Quality

March 17, 2010
8:30 a.m. – 10:10 a.m.
Room 139

Survivorship of a Dominant, Predatory Game Fish in Lake Tahoe
- John Umek

Hydroacoustics as a Tool for Fisheries Management in Fallen Leaf Lake
- Derek Bloomquist

A Contemporary Evaluation of the Nearshore Native Fishery in Lake Tahoe
- Christine Ngai

Periphyton Biomass Monitoring in the Near Shore Zone of Lake Tahoe
- Scott Hackley

Can Fallen Leaf Lake Sediments Reveal the History of Occurrence & Growth Patterns of the Lotic Stalked Diatom *Didymosphenia Geminata*?
- Andy Rost

Survivorship of a Dominant, Predatory Game Fish in Lake Tahoe

John Umek*
Sudeep Chandra, Ph.D.
Department of Natural Resources and Environmental Sciences,
University of Nevada, Reno

Patrick Lemons
USGS Anchorage Alaska

***University of Nevada, Reno, Department of Natural Resources & Environmental Sciences, 1000 Valley Road, Reno, Nevada 89512, (775) 784-7514, umekj@unr.nevada.edu**

Introduced in 1910, Lake trout (*Salvelinus namaycush*) are the dominant, predatory gamefish in Lake Tahoe. However, little is known about their survival rates and the factors that may influence survival. Survival is a fundamental factor governing the persistence of a population and estimation of survival rates typically comes from removal methods or mark-recapture methods. Considering Lake Tahoe is undergoing progressive eutrophication and disruptions to the nearshore due to introduced species, it is important to gain insight into changes in survivorship before further alterations occur. Using mark-recapture analysis with previously collected information and a lake trout fishing company, we have determined survivorship of lake trout over two time periods (1985 to 1995 and 2005 to 2009). Survival rates were estimated using a Burnham Survivor model in program MARK, and a series of models were constructed to examine the effect of year, size, depth of capture, and sex on survival rates. Akaike's information criterion was used to determine the best-fit model.

Preliminary results derived from 3217 marked fish suggest survival estimates declined between 1985 and 1989 but steadily increased between 1990 and 1995. The most important factors influencing survival between the years 1985 and 1995 were the size of the fish and the depth the fish was caught. Further analysis will be conducted in the latter time period to make comparisons. Overall estimates of survivorship are greater at Lake Tahoe versus the Laurentian Great Lakes.

Hydroacoustics as a Tool for Fisheries Management in Fallen Leaf Lake

Derek Bloomquist

US Fish & Wildlife Service, 1340 Financial Boulevard, Suite 234, Reno, Nevada 89502. (775) 861-6315, Derek_Bloomquist@fws.gov

Funded by: US Fish & Wildlife Service, Southern Nevada Public Lands Management Act

The use of hydroacoustic remote sensing technology was explored as a possible non-intrusive, repeatable method for monitoring distribution and abundance of fish and to map the sub-surface habitat in Fallen Leaf Lake, CA. Because this is an indirect measurement technique the collected data must be validated or "ground truthed". Preliminary work in this study involved adjusting the system parameters and collection protocols to best capture the biotic assemblage and lake characteristics. Then underwater video, scuba and fish collection were used to correlate the acoustic data with the actual conditions. Using these techniques we obtained a measure of fish community size ranges and abundance, compared night and day acoustic surveys, located lake trout spawning sites, tested the applicability to monitoring mysid shrimp and created a preliminary substrate/habitat map. Preliminary results suggest that hydroacoustics is an effective and efficient tool for biological monitoring in the Tahoe Basin. In addition, these methods are valuable for lake management decisions because they supply a three-dimensional image of the subsurface environment not easily attained by traditional methods.

A Contemporary Evaluation of the Nearshore Native Fishery in Lake Tahoe

Christine Ka Lai Ngai*
Joseph Sullivan
John Umek
Sudeep Chandra, Ph.D.

***Department of Natural Resources & Environmental Science, University of Nevada, Reno, 1000 Valley Road, Mail Stop 186, Reno, Nevada 89512, cngai@cabnr.unr.edu. (775) 881-7570**

Funding source: Lake Tahoe Southern Nevada Public Lands Management Act, US Forest Service Lake Tahoe Basin Management Unit, Nevada Division of State Lands License Plate Fund

Management agencies in Lake Tahoe have taken a strong interest in managing the nearshore fishery due to increased distribution of nonnative plant (e.g. water milfoil *Myriophyllum spicatum*, curly leaf pondweed *Potamogeton crispus*) and vertebrate species (largemouth bass *Micropterus salmoides* and bluegill *Lepomis macrochirus*). Further spread of these nonnative species can lead to decline in native fish population, and disruption of their spawning habitats. Previously developed management thresholds for nearshore fishery have been found to be in non attainment, thus urging the need to develop new ecologically relevant indicators for assessing changes of the nearshore fishery and habitat.

Field sampling was conducted between May to November 2008 and 2009 at various locations in the nearshore area. Density, species composition, distribution, body condition, and diet of nearshore fishes were collected and compared with historical for assessment of long term changes in nearshore fishery. Our findings emphasize understanding nearshore densities, dynamics around the nearshore of the lake, as well as diet and life history information.

The integrity of Lake Tahoe aquatic ecosystem is threatened by multiple stressors. Recent anthropogenic disturbances, such as nearshore zone development, climate change, and introduction of nonnative species, have altered the native biota of Lake Tahoe. Therefore, management thresholds that were previously established should be updated to accommodate for these changes and future challenges to come. Present-day assessment of the condition of nearshore fishery conducted by this study is one of the essential components to achieve such goals.

Periphyton Biomass Monitoring in the Near Shore Zone of Lake Tahoe

Scott H. Hackley*
Brant C. Allen
John E. Reuter
S. Geoff Schladow

***University of California, Davis, Tahoe Environmental Research Center, 291 Country Club Drive, Incline Village, Nevada 89451. (775) 881-7560 x 7466, shhackley@ucdavis.edu**

Funding source: Lahontan Regional Water Quality Control Board and Southern Nevada Public Lands Management Act

The Lake Tahoe nearshore zone can be heavily used and is readily available to the largely shore-bound public. The accumulation of periphyton (attached algae) on rocks, piers, boats and other surfaces is a striking indicator of Lake Tahoe's declining water quality. Thick, green or white expanses of periphyton biomass often coat the shoreline in portions of the lake during the spring. In 2000, we re-initiated regular monitoring of periphyton abundance around the lake. Previous sampling occurred between 1982-85, 1989-92. Currently, algal biomass is measured at nine stations around the lake. Periphyton is collected directly from natural rock surfaces 5-8 times per year. Chlorophyll *a* content is used to estimate biomass.

Annual maximum biomass has been elevated in areas of higher urban development in the north-west portion of the lake, with levels typically ranging from ~50->200 mg/m^2 (e.g. Pineland, Tahoe City and Dollar Pt.). In contrast, annual maximum biomass has generally been lower where less urbanization occurs (e.g. Sand Point, Deadman Pt. and Zephyr Pt.). While the amount of rocky substrate is limited in the south shore, periphyton can grow attached to aquatic weeds and is now associated with Asian clams. Persistent, heavy periphyton growth on boulders was found throughout the spring and summer 2009 at Timber Cove Beach to the east of the large stream inflows. In other regions, biomass dies off after the late winter-spring peak. Patterns of growth and quantitative approaches to establish indicator benchmarks for periphyton are presented.

Can Fallen Leaf Lake Sediments Reveal the History of Occurrence & Growth Patterns of the Lotic Stalked Diatom *Didymosphenia Geminata*?

Andy Rost*
University of Nevada, Reno, Hydrologic Sciences Program,
Desert Research Institute, Division of Earth and Ecosystem Sciences

Paula Noble
University of Nevada, Reno, Geology Department

***Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada 89512. (775) 673-7633, arost@dri.edu**

In the past two decades, *Didymosphenia geminata* has received global attention because it can form benthic smothering blooms in oligotrophic streams. In the Lake Tahoe basin, there are populations in Glen Alpine and Taylor Creeks, the inlet and outlet of Fallen Leaf Lake, respectively, however, it is not known whether these streams are newly invaded or if recent prolific growth is a novel event.

Fallen Leaf Lake sediments were examined for the presence of *D. geminata* to determine whether the lake record could be used to identify when it first appeared and if occurrence patterns have changed. Surface sediments were collected at two littoral sites adjacent to the Glen Alpine inlet, one site 20m deep and 200 m directly out from the inlet, and one site 110 m deep near the deepest part of the lake.

D. geminata is common in the 20 m sample, rare in the 110 m sample, and absent from the littoral samples. *D. geminata* does not appear to be part of the lake periphyton, however dead cells were observed in lake plankton tows, confirming its transport into the lake. These findings indicate that it may be feasible to trace the history of *D. geminata* back into the lake record, however the methodology employed must address phytoplankton dilution to ensure *D. geminata* is not overlooked. If successful, this study can help determine if growth patterns have changed and timing associated with possible changes, providing insight into this locally and globally relevant issue in aquatic ecology.

Technical Session Abstracts

Monitoring Terrestrial Ecological Outcomes of the Angora Wildfire

March 17, 2010
8:30 a.m. – 10:10 a.m.
Room 141

Vegetation Conditions Two Years After the Angora Fire
- Chris Carlson

Outcomes of Post-Fire Restoration After the Angora Fire
- Tina Carlsen

Effects of Fuel Treatments on Fire Severity
in an Area of Wildland-Urban Interface During the Angora Fire
- David Schmidt

Small Mammal Community Recovery in the Angora Wildfire
- Patricia Manley

Bird Community Recovery in the Angora Wildfire
- Gina Tarbill

Vegetation Conditions Two Years After the Angora Fire

Chris Carlson*
Solomon Dobrowski
University of Montana, College of Forestry and Conservation,
Department of Forest Management

Hugh Safford
USDA Forest Service, Pacific Southwest Region
Department of Environmental Science and Policy, University of California-Davis

***University of Montana, College of Forestry & Conservation, Department of Forest Management, 12 Campus Drive, Missoula, Montana 59812. (541) 554-9783, christopher1.carlson@umontana.edu**

Funding: USDA Forest Service, Lake Tahoe Basin Management Unit

In June 2007 the Angora fire burned over 1200 hectares of mixed-conifer forest and destroyed hundreds of structures. The fire burned mixed to high severity, with over half the burn area experiencing extreme fire behavior or high rates of tree mortality. The proximity of the fire to human development has contributed to concerns over the state of post-fire vegetation including hazard trees, erosion, forest regeneration and future fuel loads. These concerns are common to burn areas and are often addressed through manipulation of forest vegetation. However, there remain gaps in our knowledge about how fire and management actions may impact the composition and diversity of vegetative communities, in part because community response is mediated by a number of other factors.

In 2008 and 2009 we measured vegetation composition, tree mortality, fuel loads, surface covers, tree regeneration and treatment history on permanent plots throughout the burn area. We use this data to investigate how fire effects, management, and environmental conditions influence post-fire vegetation.

Results from 2008-2009 show large variations in post-fire conditions. Mortality rates are linked to pre-fire stand density, and to date burned. Severely burned areas generally had lower regeneration rates, more bare soil, and less species diversity. However, pre-fire conditions (and management), topographic position, and post-fire management also play a demonstrable role in controlling post-fire vegetative structure and diversity.

Outcomes of Post-Fire Restoration After the Angora Fire

Dr. Tina Carlsen*
Judy Clot
Daylin Wade
California Tahoe Conservancy

Susie Kocher
University of California Cooperative Extension

***California Tahoe Conservancy, 1061 Third Street, South Lake Tahoe, California 96150. (530) 543-6064, tcarlsen@tahoe.ca.gov**

Funding Source: United States Army Corps of Engineers, the California Tahoe Conservancy and the University of California Extension

The Angora Fire began in the North Upper Truckee area near South Lake Tahoe on June 24, 2007. Over the ensuing days, it burned more than 3,100 acres and over 250 homes. The California Tahoe Conservancy owns and manages 229 parcels (totaling 104 acres) in the fire area, many of which were burned with moderate or high severity. After the fire, we pursued an active restoration approach. In the days immediately following the fire, we took several steps to minimize impacts to water quality and protect County and private infrastructure, including stabilizing newly-exposed slopes and removing dead and dying trees that had become a hazard. After removing the excessive fuel loads that would also threaten establishing seedlings, we planted native conifer seedlings, with subsequent irrigation and weed management as necessary to improve establishment. We also used the forest growth simulation model Forest Vegetation Simulator (FVS) to predict stand conditions 50 years after these active restoration efforts. Results of the simulations predicted that after 50 years, only the actively restored forest would approach the desired forest structure and composition. We are closely monitoring and evaluating the active restoration effort. Factors being monitored are establishment of coniferous and other desired vegetation, soil erosion, soil impacts resulting from restoration activities, ground fuel accumulation, and bird and small mammal community composition. We are also monitoring adjacent unrestored forest which had also been burned in the fire. Our results to date suggest actively restored lands are more rapidly moving towards the desired forest structure and composition.

Effects of Fuel Treatments on Fire Severity in an Area of Wildland-Urban Interface During the Angora Fire

David Schmidt*
The Nature Conservancy

Hugh Safford
USDA Forest Service, Pacific Southwest Region, Department of Environmental Science and Policy, University of California, Davis

Chris Carlson
College of Forestry and Conservation, University of Montana

*** University of California, Davis, The Nature Conservancy, 2135 Wickson Hall, Davis, California 95616. (530) 902-5333, dschmidt@tnc.org**

Funding: USDA Forest Service, Pacific Southwest Region

Recent data show that the size, frequency, and severity of wildfires are growing in the Sierra Nevada. Forest fuel treatments have been suggested as a way to protect human assets from increasing fire risk, while at the same time "restoring" more natural and resilient forest conditions. To this point, there have been few statistical assessments of fuel treatment effectiveness in moderating wildfire. In addition, most published studies of fuel treatment effectiveness have not included replication or controlled for topography and weather variation.

The 2007 Angora Fire burned 1243 ha of Jeffrey pine and mixed conifer forest in the Lake Tahoe Basin at unusually high severity due to heavy fuels; strong winds; warm, dry weather; and unseasonably low fuel moistures. The fire burned into 194 ha of fuel treatments intended to modify fire behavior and protect private and public assets, thus providing a unique opportunity to quantitatively assess the effects of fuel treatments on wildfire severity. We measured fire effects on vegetation in treated and adjacent untreated areas within the fire perimeter, immediately after and one year after the fire. Our measures of fire severity included tree mortality; height of bole char, crown scorch, and crown torch; and percent crown scorch and torch. Our study design included replication and implicitly controlled for variation in topography and weather.

Our results show that fuel treatments generally performed as designed and substantially changed fire behavior and subsequent fire effects to forest vegetation. Although there were exceptions, bole char height and fire effects to the forest canopy (measured by crown scorching and torching) were significantly lower, and tree survival significantly higher, within sampled treatments than outside them. In most cases, crown fire behavior changed to surface fire within 50 m of encountering a fuel treatment.

The Angora Fire underlines the important role that properly implemented fuel treatments can play in protecting assets, reducing fire severity and increasing forest resilience.

Small Mammal Community Recovery in the Angora Wildfire

Patricia N. Manley*
USFS Pacific Southwest Research Station, Davis, California

Eric Newkirk
Courtney Owens
USFS Pacific Southwest Research Station, Placerville, California

***Pacific Southwest Research Station, Sierra Nevada Research Center, 1731 Research Park Drive, Davis, California 95618. (530) 759-1719, pmanley@fs.fed.us**

Funding Source: California Tahoe Conservancy, US Army Corps of Engineers, Southern Nevada Public Lands Management Act

Fire is a natural and regular disturbance in forests that modifies forest structure and food availability for small mammals. Small mammals perform key functions in forested ecosystems, including seed caching, tunneling, and serving as primary prey for many upper trophic level species. Post-fire management strategies often include salvage logging and erosion control measures, which may reduce or enhance habitat suitability for small mammal species.

We used live trapping to characterize the small mammal community at 70 sites in and around the Angora wildfire area to investigate the effects of burn severity and post-fire management practices on the small mammal community and its role in forest ecosystem recovery. We completed sampling on 57 sites in 2008-2009, with one additional sample year planned for 2010. We present preliminary results on relationships between burn intensity, post-fire treatments, and small mammal community structure.

We found that species richness was lower at sites with high intensity burns. Although high intensity burn sites that had been salvaged were similar in species richness to those that had not been salvaged, species richness did not increase at lower intensity burns where thinning or salvage had occurred. Alternatively, small mammal abundance was not greatly affected by burn intensity; however, treatments appeared to have a positive effect on abundance at higher intensity burns. Our preliminary results suggest that there is an important interaction between burn intensity and post-fire forest management that affects the small mammal community recovery, and that post-fire management can be designed to achieve multiple recovery objectives.

Bird Community Recovery in the Angora Wildfire

Patricia N. Manley*
USFS Pacific Southwest Research Station, Sacramento State University

Gina Tarbill
USFS Pacific Southwest Research Station

T. Will Richardson
University of Nevada, Reno

***Pacific Southwest Research Station, Sierra Nevada Research Center, 1731 Research Park Drive, Davis, California 95618. (530) 759-1719, pmanley@fs.fed.us**

Funding Source: California Tahoe Conservancy, US Army Corps of Engineers, Southern Nevada Public Lands Management Act

Fire is a natural and regular disturbance in forests that modifies forest structure, creates snags, and alters arthropod populations. Thus, fire both destroys and creates habitat for birds. Post-fire management strategies often include salvage logging and erosion control measures. These management activities alter the post-fire landscape and may reduce or enhance habitat suitability for individual species or guilds of birds. Cavity-excavating birds are likely to be particularly influential in recovering wildlife communities in that they create cavities, which are often limited following a high-intensity wildfire.

We surveyed the bird community and located nests of primary cavity excavators to investigate the effects of burn severity and post-fire management practices on the bird community and its role in forest ecosystem recovery. We completed sampling on 70 sites in 2008-2009, with one additional sample year planned for 2010.

We found that burn intensity did not affect species richness at sites with no treatment, with the exception of sites with 100% mortality, which had substantially lower richness. Salvage logging had limited effects on species richness except when most or all of the trees were removed. In contrast, bird abundance declined with burn intensity regardless of the treatment. Substrate use by primary cavity excavators differed among species, with Black-backed and Hairy woodpeckers showing a greater affinity for burned forests than White-headed woodpecker. Our results suggest that forest management to reduce fuels and post-fire management activities can be compatible with retaining and recovering native bird communities.

Technical Session Abstracts

Modeling the 21st Century Impacts of Climate Change in the Tahoe Basin

March 17, 2010
8:30 a.m. – 10:10 a.m.
Room 106

Projections & Downscaling of Climate Change
for the Sierra Nevada & Lake Tahoe
- Michael Dettinger

Climate Change Impacts in the Tahoe Region:
Past & Projected Future Trends
- Robert Coats

Hydrologic Impacts of Climate Change at the Watershed Scale
- John Riverson

The Response of Lake Tahoe to Climate Change
- Goloka Sahoo

Implications of Climate Change for Design of
Best Management Practices in the Tahoe Basin
- Brent Wolfe

Projections & Downscaling of Climate Change for the Sierra Nevada & Lake Tahoe

Michael Dettinger

US Geological Survey, Scripps Institution of Oceanography, La Jolla, California.

Current projections of global climate changes in response to increasing greenhouse-gas concentrations in the atmosphere include warming in the vicinity of the Sierra Nevada and Lake Tahoe of anywhere from about +3ºC to +6ºC by end of century and changes in precipitation on the order of 5-10% increases or (more commonly) decreases, depending on the climate model considered. Along with these basic changes, other climate variables like solar insolation, downwelling (longwave) radiant heat, and winds may change. Together these climate changes are likely to result in changes in the hydrology and runoff into Lake Tahoe and potential changes in lake overturning regimes.

Current climate projections, however, are generally too spatially coarsely resolved (with grid cells typically separated by 1 to 2º latitude and longitude) for direct applications to evaluations of potential impacts on the much smaller Lake Tahoe catchment. Thus selected global projections have been downscaled by a statistical method called the constructed-analogs method onto 10 to 12 km grid scaling over the West and especially over Lake Tahoe. Temperatures, precipitation, winds, and downward radiation fluxes have been downscaled from several 21st Century climate-change projections, for use in impact evaluations as part of an assessment funded by the USDA Forest Service Pacific Southwest Research Station and Bureau of Land Management described elsewhere in this session.

Climate Change Impacts in the Tahoe Region: Past & Projected Future Trends

Robert Coats

Tahoe Environmental Research Center & Hydroikos Ltd., 2512 9th Street, Suite 7, Berkeley, California 94710. (510) 295-4094, coats@hydroikos.com

This research is supported in part by grant #08-DG-11272170-101 from the USDA Forest Service Pacific Southwest Research Station using funds provided by the Bureau of Land Management through the sale of public lands as authorized by the Southern Nevada Public Land Management Act.

Analysis of 20th century air temperature, snowfall, stream discharge and lake temperature records in the Tahoe Basin indicate strong upward trends in air temperature, a shift from snow to rain, a shift in snowmelt timing to earlier dates, increased rainfall intensity, increased interannual variability of precipitation, and warming of the Lake. With down-scaled output from two General Circulation Models (the Geophysical Fluid Dynamics Laboratory, or GFDL, and the Parallel Climate Model, or PCM) and two emissions scenarios (A2 and B1), we can now project future trends in temperature, precipitation and drought conditions for the Basin. The steepest trend (GFDL with A2) indicates about 5 oC warming by the end of the 21st century. Precipitation trends are more modest with a slight dip in latter half of the 21st century indicated by the GFDL/A2 case, but not the others. Comparisons with the Palmer Drought Severity Index show that drought will increase in spite of the lack of strong trends in precipitation. Continued warming in the Tahoe basin is likely to result in 1) increased tree mortality, and increased fuel loads; 2) increased wildfire frequency and intensity; 3) continued shift from snow to rain; 4) increased intensity of rainfall, with concomitant increases in surface soil erosion, flood peaks and channel erosion; 5) changes in the theoretical climax vegetation. The management response to these climate change impacts may include aggressive fuel load reduction, establishment of plant communities and species adapted to lower elevations, more erosion control projects, and redoubled efforts to control nutrient flux to the lake.

Hydrologic Impacts of Climate Change at the Watershed Scale

John Riverson*
Clary Barreto

***Tetra Tech, 10306 Eaton Place, Suite 340, Fairfax, Virginia 22030. (703) 385-6000, john.riverson@tetratech.com**

This research is supported in by grant #08-DG-11272170-101 from the USDA Forest Service Pacific Southwest Research Station using funds provided by the Bureau of Land Management through the sale of public lands as authorized by the Southern Nevada Public Land Management Act

This study aims to characterize the impact of climate change on watershed-scale hydrology. The authors hypothesize that (1) the shift of precipitation from snow to rain, and increased frequency of rain-on-snow events will increase fine sediment and nutrient loading to the lake, and (2) the magnitude and frequency of BMP hydraulic loading will increase with climate change. These hydrologic changes will likely influence (1) the future clarity of the Lake and (2) BMP management decisions.

For the Lake Tahoe TMDL, Tetra Tech previously developed a watershed hydrology and pollutant loading model of the Lake Tahoe Basin using the Load Simulation Program in C++ (LSPC). This continuous simulation model uses locally observed weather data as the forcing boundary condition, together with watershed characteristics (such as existing land use coverage, elevation, slope, and soils) to simulate hydrology. Measured stream discharge and water quality were used to calibrate existing condition loads of fine sediment load and nutrients to the lake.

To test the hypotheses, the downscaled climate change projections for the Sierra Nevada and Lake Tahoe were substituted as the climate boundary condition to drive the watershed model and compare trends relative to the baseline condition.

Snowfall/snowmelt patterns and the resulting impact on watershed hydrology and pollutant loading will be influenced by these climate change projections. The degree to which this occurs, and the resulting impacts to Lake and BMP loading, are being evaluated through this research. The findings will be presented during the oral session.

The Response of Lake Tahoe to Climate Change

G. B. Sahoo*
S. G. Schladow
Tahoe Environmental Research Center,
Department of Civil and Environmental Engineering, University of California, Davis

J. E. Reuter
Tahoe Environmental Research Center,
Department of Environmental Science & Policy, University of California, Davis

R. Coats
Tahoe Environmental Research Center, University of California, Davis

*** University of California, Davis, Tahoe Environmental Research Center, Davis, California 95616. University of California, Davis, Department of Civil & Environmental Engineering, Davis, California 95616. (530)752-1755, gbsahoo@ucdavis.edu**

This research is supported by University of California Davis & grant #08-DG-11272170-101 from the USDA Forest Service Pacific Southwest Research Station using funds provided by the Bureau of Land Management through the sale of public lands as authorized by the Southern Nevada Public Land Management Act.

Meteorology exerts a large influence on a lake's internal heating, cooling, and mixing, which, in turn, affect important features of lake water quality and ecology. In Lake Tahoe, the mixing depth varies each year. Records spanning the last 40 years show that the lake completely turns over once in every three to four years during winter. Full mixing homogenizes the entire water column. Deep mixing not only supplies dissolved oxygen to the hypolimnion but also alters the distribution of suspended fine particles and nutrients below the photic zone. Records show that Lake Tahoe volume averaged water temperature has increased approximately 0.013 oC per year and the resistance of the lake to mixing has concomitantly increased. With continued climate change, Lake Tahoe will be warmer and more stable to mixing resulting in accumulated water quality problems over time.

Predictions of two Global Climate Models: Geophysical Fluid Dynamics Laboratory and Parallel Climate Model predictions for the A2 and B1 scenarios were downscaled to approximately 12km × 12km resolution. Biases in the downscaled data were corrected before using in the model. The calibrated lake clarity model was used to simulate thermodynamic and water quality properties of the lake for next 50-years.
The 50-simulation results show that (1) the lake becomes warmer and more stable and (2) there is pronounced changes in deep winter mixing, spring stratification, and dissolved oxygen patterns.

Climate change is inevitable. Thus, current lake management strategies should be integrated with new approaches and methodologies in order to address the water quality problems associated with climate change and extreme events.

Implications of Climate Change for Design of Best Management Practices in the Tahoe Basin

Brent Wolfe

Northwest Hydraulic Consultants, 870 Emerald Bay Road, Building B, Suite 308, South Lake Tahoe, California 96150. (530) 544-3788, bwolfe@nhcweb.com

Funding Source: Southern Nevada Public Land Management Act grant #08-DG-11272170-101

The implications of climate change for the design of water quality BMPs are unknown. Specifically, what potential changes in the performance of storm water quality improvement projects, and certain types of controls (private property BMPs, detention basins, etc.), may occur under varying climate change scenarios?

The Pollutant Load Reduction Model (PLRM) is a long-term continuous simulation model for the Tahoe Basin that is capable of assessing pollutant loads from combinations of BMPs and various land uses that comprise typical local agency storm water quality improvement projects. The assessment is using meteorological data developed from the climate change models to run the PLRM to quantify the performance of individual storm water treatment facilities, as well as urban storm water quality improvement projects under climate change scenarios.

As a result of potential climate changes, the pollutant load reduction achieved by water quality improvement projects may change. The following questions are being explored through this research. Results and conclusions will be presented at the conference.

1. How will changes to runoff affect the hydraulic capture for specific storm water treatment facilities (e.g., dry basin, cartridge filter, infiltration basin, etc.)?
2. What are the potential changes in the performance of pollutant load reductions for (i) private property BMPs (ii) storm water treatment facilities (e.g., dry basin, cartridge filter, infiltration basin, etc.) and (iii) storm water quality improvement projects that represent land uses and BMP types/configurations that illustrate typcial strategies employed for water quality improvement?

Technical Session Abstracts

Tahoe's Native Fish Crisis: Status & Restoration of Native Fish Populations

March 17, 2010
10:40 a.m. – 12:00 p.m.
Room 139

Tahoe's Native Fish Crisis:
Status of & Solutions for Restoring Our Native Fish Populations
- Jenny Hatch

Lahontan Cutthroat Trout in the Upper Truckee River:
Restoration of a Threatened Species in a Fluvial Headwater Environment
- Richard Vacirca

Native Non-Game Fish Assessment Survey
in the Lake Tahoe Basin
- Maura Santora

Application of a GIS-Based Assessment Tool
to Evaluate Status & Risks for Lahontan Cutthroat Trout
in the Tahoe Basin & Range-Wide in a Changing Climate
- Helen Neville

Tahoe's Native Fish Crisis: Status of & Solutions for Restoring Our Native Fish Populations

Jenny Marie Hatch*
California Trout

Dr. Peter B. Moyle
University of California, Davis, Dept of Wildlife, Fish and Conservation Biology

***California Trout, 870 Emerald Bay Road, Suite 303, South Lake Tahoe, California 96150. (530) 541-3495, jfrancis@caltrout.org**

In the *State of Salmonid (SOS): California's native fish crisis* report, researchers have discovered that nearly 65% of California's native fish may go extinct in the next century if action is not taken immediately. Current efforts are underway to restore LCT to the Tahoe/Truckee watershed however, habitat alteration, abundant alien species, and the loss of inter-connected populations have left managers trying to recover this species with very little habitat available for re-introductions.

The key approach to success of Tahoe's native trout are, to eliminate competing non-native species, provide sufficient water flows, ensure habitat connectivity, sustain genetic integrity, and to protect and restore ecosystem functions necessary for recovered populations.

Moyle et. al developed their ranking for each species by considering existing population size, intervention needs, and tolerance to stochastic events, genetic risk, climate change, existing occupied range, and reliability of this ranking to existing research.

The Lahontan cutthroat trout received a ranking of a 2, indicating that they have a poor likelihood of survival as a species in the next century. Conservation recommendations include habitat connectivity, non-native fish elimination in restored water bodies, public outreach, conservation of non-game species, and continued genetic sustainability.

In conclusion, we will use the tools of the SOS report and findings of the existing restoration and monitoring efforts to discuss what is effective and should be employed in future recovery of this species in the Tahoe Basin.

Lahontan Cutthroat Trout in the Upper Truckee River: Restoration of a Threatened Species in a Fluvial Headwater Environment

Richard Vacirca

US Forest Service, Lake Tahoe Basin Management Unit. (530) 543-2768, rvacirca@fs.fed.us

Funding Source: Southern Nevada Public Lands Management Act

By the 1950's LCT were locally extirpated from Lake Tahoe as a result of wide-spread salmonid introductions, over-harvest and habitat modification. Lahontan cutthroat trout (LCT) were listed as endangered by the US Fish and Wildlife Service in 1970 and subsequently reclassified as threatened in 1975, under the Endangered Species Act, to facilitate management and allow regulated angling. Federal and state agencies are tasked with restoring LCT in Lake Tahoe basin while facing wide-spread distributions of introduced/non-native fishes that currently occupy suitable habitats.

The species was reintroduced to the headwaters of the Upper Truckee River in Meiss Meadows in 1989 and 1990 by reclaiming a total of 4 stream miles. Reclamation activities involved conducting non-native brook trout removal by means of electrofishing from the Upper Truckee River prior to LCT introduction. Similar efforts to expand upon the Meiss Meadow population into downstream habitats were initiated in 2008 and are expected to continue over the next 5 – 8 years.

Since 2007, no brook trout were discovered in the Meiss Meadow stream reaches. Since 2008, measureable depletion on brook trout was noted in treatment reaches within the LCT expansion area.

Non-native fishes compete with native species, such as LCT where they have been introduced. Management of non-native fishes is an important consideration in the overall LCT recovery strategy, especially where such efforts could take place in other fluvial environments using similar removal methods.

Native Non-Game Fish Assessment Survey in the Lake Tahoe Basin

Maura K. Santora*
Richard Vacirca

***US Forest Service, Lake Tahoe Basin Management Unit (LTBMU), 35 College Drive, South Lake Tahoe, California 96150. (560) 543-2622, msantora@fs.fed.us**

Funding Source: Southern Nevada Public Lands Management Act

Information about the historical and current status of native non-game fish communities in the Lake Tahoe basin is almost non-existent. The Lake Tahoe Basin Management Unit (LTBMU) is conducting a fish assessment survey on state and federal lands within the basin to determine species presence, distribution, and relative abundance, to build a baseline to inform future watershed and ecosystem level management decisions.

Beginning in 2007, streams were sampled from the mouth to the headwaters using electrofishing methods. Fish were measured and species identified.

The survey of the west and south shores of the basin is 50-65% completed, with 22 streams surveyed. Of the 13 species found, 7 native species were documented: Lahontan redside (*Richardsonius egregious*), speckled dace (*Rhinichthys osculus*), Tahoe sucker (*Catostomus tahoensis*), mountain sucker (*Catostomus platyrhynchus*), Paiute sculpin (*Cottus beldingi*), mountain whitefish (*Prosopium williamsoni*), and Tui chub (*Gila bicolor*). Early indications show limited distributions of native fishes, with the majority of species found only in the lower third portion of watersheds.

The 6 non-native species sampled include: rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), bullhead catfish (*Ameiurus nebulosus*), bluegill (*Lepomis macrochirus*), and goldfish (*Carassius auratus auratus*).

Native fish species were generally uncommon, while non-native trout were most common in nearly all creeks surveyed. Non-native fishes may be out-competing some native non-game species. Management of non-native fishes may be an important consideration in conserving populations of native fishes in the Lake Tahoe basin.

Application of a GIS-Based Assessment Tool to Evaluate Status & Risks for Lahontan Cutthroat Trout in the Tahoe Basin & Range-Wide in a Changing Climate

Helen Neville*
Jack Williams
Amy Haak
Kurt Fesenmeyer

***Trout Unlimited, 910 West Main Street, Suite 342, Boise, Idaho 83702. (208) 345-9800, hneville@tu.org**

Funding comes from the Hewlett Foundation & the US Geological Survey

Building an effective strategy for species conservation requires evaluation of the current status of populations and their habitats as well as an understanding of factors likely to threaten populations in the future. We present a recent application of Trout Unlimited's Conservation Success Index (CSI) to address these questions for Lahontan cutthroat trout in the Tahoe basin and throughout its range. The CSI is a GIS-based, subwatershed-scale assessment tool that synthesizes and communicates the range-wide condition and management needs of coldwater fishes in a comprehensive and consistent framework, providing a unique capacity for evaluating the spatial attributes of fish populations and their habitats and characterizing emerging threats. It analyzes 20 indicators of population and habitat status that can be grouped into four general categories: range-wide conditions, population integrity, habitat integrity, and future security. Much of the data in the CSI comes from the recently-released 5-year review of LCT, but we also incorporate analyses of various geospatial datasets that reflect watershed and aquatic habitat conditions. Additional analyses related to threats such as energy development, non-native species, and climate change provide a landscape-scale blueprint of risks and strategic management options for LCT in the Tahoe basin and other parts of the sub-species' range. Results indicate the Tahoe basin will be at high risk for fire and winter flooding, and emphasize the need for restoration efforts that ensure the ability of LCT to deal with these emerging threats in the future.

Technical Session Abstracts

Characterizing Aquatic Effects of the Angora Wildfire

March 17, 2010
10:40 a.m. – 12:00 p.m.
Room 141

Characterization of Water Quality in Angora Creek
Following the June 2007 Angora Fire
- John Reuter

Characterization of Nitrogen & Phosphorus Loading
From Angora Creek Following the June 2007 Angora Fire
- Allison Oliver

Tracking Fine Sediment Particles in Urban Runoff
& Following the Angora Fire
- Alan Heyvaert

Characterizing Stream Ecosystem Response Using
Benthic Macroinvertebrate Communities & Habitat Parameters
in Angora Creek Following the June 2007 Angora Fire
- Allison Oliver

Characterization of Water Quality in Angora Creek Following the June 2007 Angora Fire

John E. Reuter*
Raph Townsend
Collin Strasenburgh
Tahoe Environmental Research Center,
University of California, Davis

Alan C. Heyvaert
Desert Research Institute

Allison Oliver
Department of Land, Air and Water Resources,
University of California, Davis

***University of California, Davis, Department of Environmental Science & Policy, One Shields Avenue, Davis, California 95616. (530) 304-1473, jereuter@ucdavis.edu**

Funding for the Angora Fire monitoring was provided by the Lahontan Water Board, the California Tahoe Conservancy, the USFS-Lake Tahoe Basin Management Unit and monitoring assistance from the USGS (Carson City, NV).

The Angora Fire began June 24, 2007 in the Upper Truckee River watershed and burned ~3,100 acres. Most of the upper portion of the Angora Creek watershed (including an urban subdivision) lies within this burned area. Tahoe researchers, in collaboration with state, federal and local resource agencies, implemented an extensive water quality monitoring program to evaluate impacts from this fire. Samples were collected during Water Years 2008 and 2009, including continuous flow measurements. Samples were analyzed for nutrients, TSS, NTU and other parameters in Angora Creek both above (AU; n=100) and below (AL; n=101) the burned subdivision. A third Angora Creek site, near its confluence with the Upper Truckee River, was sampled by the USGS. Autosampler methods and standard USGS protocols were employed throughout. Results are presented as constituent concentrations.

Precipitation for WY08 (22.5 inches) and WY09 (27.2 inches) were both below average. The fire caused increased concentrations relative to an 11-year record of pre-fire monitoring by the USFS-LTBMU (1991-2001). Average annual concentration of nitrate increased ~8.5-fold post-fire, as commonly reported in the literature. TKN/TN was 1.6 to 2.0-fold higher after the fire, TP increased 1.9-fold, TSS increased 2.0-fold, and NTU was 3.9-folder higher. Only nitrate declined between WY08 and WY09. The high nitrate concentrations seen at AU and AL were not observed downstream near the confluence with the Upper Truckee River. Levels of nitrogen remained moderate during a large May 2009 rain event, although phosphorus, TSS and NTU showed elevated spikes similar to previous peaks for these constituents.

Characterization of Nitrogen & Phosphorus Loading From Angora Creek Following the June 2007 Angora Fire

Allison Oliver*
Department of Land, Air and Water Resources,
University of California, Davis

John E. Reuter
Raph Townsend
Collin Strasenburgh
Tahoe Environmental Research Center,
University of California, Davis

Alan C. Heyvaert
Desert Research Institute

***Department of Land, Air & Water Resources, University of California, Davis, One Shields Avenue, Davis, California 95616. (530) 219-5728, aaolvier@ucdavis.edu**

Funding provided by Kearny Soil Science Foundation, UC Davis Graduate Group in Ecology, Jastro Shields Fellowship, the Lahontan Water Board, the California Tahoe Conservancy, the USFS-Lake Tahoe Basin Management Unit and monitoring assistance from the USGS (Carson City, NV).

Nutrient loading from streams contributes approximately 20% of N and 29% of P annual nutrient budgets to Lake Tahoe. The Angora Fire began in the Lake Tahoe Basin in June 2007, and burned ~3100 acres including much of the upper Angora Creek watershed. To better understand effects of the fire on water quality, we examined spatiotemporal patterns in post-fire N and P loading. Three locations on Angora Creek were monitored continuously for two years post-fire. Angora Creek sites were located within the burn, below the burn, and above the confluence with the Upper Truckee River. At this time, data is still being analyzed. Baseflow concentration and instantaneous discharge were used to estimate daily, monthly, seasonal, and yearly loading. Loads were calculated for distinct precipitation events. Results were compared between sites on Angora Creek, as well with non-burned streams in the Tahoe Basin using unit-area loads to examine seasonal and annual differences across watersheds. Historical water quality data from Angora Creek was used to make comparisons between pre and post-fire conditions.

Angora Creek flows into the Upper Truckee River, the largest tributary to Lake Tahoe. We used a 20-year monitoring record from the Upper Truckee River to investigate potential fire effects on stream nutrient loading to Lake Tahoe. No differences were detected in mean loads in the Upper Truckee between pre and post fire years. The small size of Angora Creek relative to the Upper Truckee and low levels of post-fire precipitation likely contributed to the lack of significant downstream loading.

Tracking Fine Sediment Particles in Urban Runoff & Following the Angora Fire

Alan C. Heyvaert*
Jim Thomas
Desert Research Institute

John E. Reuter
S. Geoffrey Schladow
Tahoe Environmental Research Center, UC Davis

***Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada 89551. (775) 851-9619, Alan.Heyvaert@dri.edu**

Funding was provided by the Lahontan Water Board, the California Tahoe Conservancy, Nevada Division of Environment Protection, Southern Nevada Public Land Management Act and the USFS-Lake Tahoe Basin Management Unit.

Research for the Lake Tahoe TMDL found that fine sediment particles (0.5–16 µm size range) have significant affect on lake clarity. While particle loading is generally minimal from undisturbed lands, it can be substantial in runoff from urbanized areas, and there is little data regarding fine particle generation and transport after forest fires. This work presents results from studies that have analyzed suspended sediment samples from urban and roadway sources, and from burned areas following the Angora wildfire. Several urban sites at Tahoe have been monitored since 2004, while the Angora wildfire areas have been monitored since July 2007. Particle concentrations were measured at each of these sites, including Angora Creek both above and below the burned Angora residential subdivision. Fine particle concentrations in Angora Creek ranged from 0.3x105 to 3.5x105 particles/mL, and were generally higher below the burned subdivision, with average flow-weighted concentrations (AFWC) of 0.8x105 particles/mL at the upper creek site and 1.8x105 particles/mL at the lower creek site. By comparison, particle concentrations in LTIMP streams (2002–2003) averaged ~1.3x105 particles/mL. Fine particle concentrations in runoff from Angora burned residential areas ranged from 0.05x105 to 26x105 particles/mL (AFWC of 0.8x106 particles/mL), and increases in particle concentrations at the lower creek site coincided with peak urban flows and particle concentrations. In contrast, urban particle concentrations measured elsewhere around Tahoe ranged from 9.0x106 to 82x106 particles/mL. Particle concentrations in Angora Creek were substantially higher during the second year of monitoring, suggesting that evaluations should continue as the burned areas recover.

Characterizing Stream Ecosystem Response Using Benthic Macroinvertebrate Communities & Habitat Parameters in Angora Creek Following the June 2007 Angora Fire

Allison Oliver*
Randy Dahlgren
Department of Land, Air and Water Resources
University of California, Davis

Dave Herbst
Sierra Nevada Aquatic Research Laboratory,
University of California, Davis

***University of California, Davis, LAWR, One Shields Avenue, Davis, California 95616. (530) 219-5728, aaoliver@ucdavis.edu**

Funding provided by Jastro Shields Fellowship, Kearny Soil Science Foundation, Lahontan Regional Water Quality Control Board, California Tahoe Conservancy

Wildfire influences aquatic ecosystems in a variety of ways. Post-fire effects are associated with a large suite of watershed variables, thus making it difficult to predict and interpret stream ecosystem condition based on water quality data alone. Benthic macroinvertebrate communities are important bioindicators of ecosystem structure and function and can reflect the extent of disturbance. Here we present estimates of benthic macroinvertebrate populations, stream habitat parameters, and bioenergetic resources (periphyton C:N ratios, temperature, etc) in Angora Creek for two years following the 2007 Angora Fire. Sites within and below the burned area were sampled during two consecutive summers and results compared to pre-fire data. Changes in community structure were evaluated over time and in relation to bioenergetic resources and habitat parameters, as well as in the context of unburned regional reference streams.

Preliminary results indicate shifts in benthic community structure that reflects habitat alteration in the burned stream reach. Post-fire communities were composed of more generalist feeders, however overall diversity remained high. Downstream communities did not exhibit similar patterns, indicating fire effects were not largely felt downstream. Compared to unburned reaches, the burned reach showed significant differences in water temperature, periphyton C:N ratios, percentage of fine substrate, and habitat complexness. It is hypothesized that high diversity within the burn area resulted from a combination of increased habitat heterogeneity and increased food quantity and quality. Following two years of monitoring, the Angora Fire does not appear to have had significant negative effects on stream ecosystem invertebrate communities.

Technical Session Abstracts

Air Quality & Burning

March 17, 2010
10:40 a.m. – 12:00 p.m.
Room 106

Time & Size-Resolved Aerosol Measurements
Above the Lake Tahoe Surface During Summer Conditions
- Courtney Siu

CANSAC Fire Weather & Smoke Management Products
for the Lake Tahoe Basin
- Francis Fujioka

Particle & Air Toxics Emissions from Prescribed Burning:
Effects of Fuel Type & Moisture Content
- L.W. Antony Chen

Nutrient Emissions from Prescribed Fire in the Lake Tahoe Basin:
Implications from Field & Laboratory Observations
- April J. Shackelford

Time & Size-Resolved Aerosol Measurements Above the Lake Tahoe Surface During Summer Conditions

Courtney Siu*
University of California, Davis
Department of Civil & Environmental Engineering

Thomas A. Cahill
David E. Barnes
Tahoe Environmental Research Center

Geoffrey Schladow
University of California, Davis
Department of Civil & Environmental Engineering
Tahoe Environmental Research Center

***University of California, Davis, Department of Civil & Environmental Engineering, 2001 Engineering Unit III, One Shields Avenue, Davis, California 95616. (530) 752-1120, casiu@ucdavis.edu**

Funding provided by US Environmental Protection Agency Region 9

Though there is a wealth of aerosol data for the Lake Tahoe Basin, data useful to estimate the impacts on water clarity are limited due to poor time and size resolution and short-term events, such as diurnal events, being unresolved. There are few measurements on the lake itself, and coarse particle data (>2.5μm), important for water quality, were not collected. Rotating DRUM samplers distribute aerosols into eight different size ranges, providing time (typically three hours) and size resolved data for eight size ranges. During the summer of 2008, these samplers were operated at two locations on the perimeter of the lake (Incline Village, NV and Tahoe City, CA) and one location on the lake. The resulting data were analyzed for elemental mass and total mass. The latter can be used to calculate deposition onto the lake. The data exhibited strong diurnal variations and clear signals from wildfires. During this summer, evidence of a wildfire was seen at all three sites in equal magnitude, but due to meteorological conditions, the deposition of phosphorus and fine particles was minimal. Coarse particles were seen over the lake, indicating summer dust is more important than previously assumed and may require additional management efforts. On-lake data were often similar to the Incline Village data, indicating that lake deposition might be inferred from monitoring at the more convenient Incline Village location. This correlation should be confirmed, but could lead to less expensive basin monitoring requirements overall.

CANSAC Fire Weather & Smoke Management Products for the Lake Tahoe Basin

Francis Fujioka*
Domagoj Podnar
Desert Research Institute

Francis Fujioka
USFS Forest Service, Pacific Southwest Research Station

***Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada 89512. (775) 674-7090**

The California and Nevada Smoke and Air Committee (CANSAC) is a consortium of multi-agency fire weather and air quality decision-makers, managers, meteorologists and scientists in partnership to provide operational meteorological support for wildland fire and smoke management. The operational component of CANSAC is implemented at the Desert Research Institute (DRI) program for Climate, Ecosystem and Fire Applications (CEFA) in Reno, Nevada. CEFA's team of scientists and technical experts in climate and ecosystem studies develops products for wildland fire and resource management. CANSAC consortium members include USFS Region 5, USFS Pacific Southwest Research Station, the National Park Service, the Bureau of Land Management, the US Fish and Wildlife Service, the California Air Resources Board and the San Joaquin Air Pollution and Control District. These agencies utilize CANSAC products for fire weather and smoke management forecasts and forecast guidance.

CANSAC operational meteorological forecasts are currently generated on a three-nested domain covering a large area of the Western US, and focusing on California and Nevada at the highest resolution (4-km). The model is initialized twice daily with the North American Meso (NAM) model and run out to 72-hours. CANSAC's Operational Applications Group comprised of users within the CANSAC community supervises all development of CANSAC products, which can be found on the web at http://cefa.dri.edu/COFF. CANSAC will be implementing a 2-km Weather Forecasting and Research (WRF) model domain in early 2010.

This presentation describes the products, decision-support tools and research in CANSAC, with emphasis on the Lake Tahoe Basin.

Particle & Air Toxics Emissions from Prescribed Burning: Effects of Fuel Type & Moisture Content

L.W. Antony Chen*
Dongzi Zhu
Judith C. Chow
Division of Atmospheric Sciences, Desert Research Institute

Paul Verburg
April J. Shackelford
Division of Earth & Ecosystem Sciences, Desert Research Institute

Rick Susfalk
Division of Hydrological Sciences, Desert Research Institute

***Division of Atmospheric Sciences Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada 89512. (775) 674-7028, antony@dri.edu**

Funding Source: This research was supported by the Bureau of Land Management through the sale of public lands as authorized by the Southern Nevada Public Land Management Act.

The decision of deploying prescribed burning against other forest fuel management options often depends on the degree of impact of prescribed burns on air quality and ecological system through released particulate matter (PM), air toxics, and nutrients. The emissions are sensitive to the fuel type (e.g., plant species, leaves versus stems), and in addition, fuel moisture that varies with season and meteorological conditions control the fire behavior to a great extent during prescribed burning and influences the emission characteristics. In this study, forest-floor fuels acquired from the Lake Tahoe Basin are categorized into soil, duff, and litter, and leaves and stems of Squaw Carpet, Bitterbrush, Greenleaf Manzanita. Samples were artificially wet to three different moist levels for laboratory-controlled combustion experiments. Measured parameters included emitted particle mass, number concentration, and size distribution, organic/inorganic air toxics, and gaseous and particulate nitrogen species in the smoke. Regardless of fuel type, combustion efficiency decreased with increasing moisture content, and lower combustion efficiencies resulted in more particles and some air toxics emissions. Dry fuels produced less PM, but the PM consisted of black carbon of larger particle sizes, which along with particle-bound polycyclic aromatic hydrocarbons (PAHs), could still be of great health concern. Nutrient species shifted from gaseous phase to particulate phase as fuel moisture increased. The moisture effect tends to be larger for stems and litter which generate more intense flaming fires. Fuel-based emission factors are reported, and their Implication for air and water quality is discussed.

Nutrient Emissions from Prescribed Fire in the Lake Tahoe Basin: Implications from Field & Laboratory Observations

April J. Shackelford*
Paul S.J. Verburg
L.W. Antony Chen
Richard B. Susfalk
Desert Research Institute

***Desert Research Institute, Division of Earth & Ecosystem Science, 2215 Raggio Parkway, Reno, Nevada 89512. (775) 674-7565, april.shackelford@dri.edu**

This research was supported using funds provided by the Bureau of Land Management through the sale of public lands as authorized by the Southern Nevada Public Land Management Act.

Prescription fire is a common management practice for reducing excessive forest fuel loading to minimize the risk of wildfire. However prescription fire may impact air and water quality by releasing nutrients from soils and vegetation upon combustion. This study assesses the carbon (C) and nitrogen (N) release as affected by fuel moisture during a prescription fire near Incline Village (NV) following mechanical thinning. The field component of this study involved a pre- and post-fire fuel inventory to estimate C and (in)organic N losses and speciation under fall fuel moisture conditions. The lab component of the study further investigated effects of moisture on nutrient release and speciation by artificially wetting fuels followed by combustion in a custom designed combustion chamber allowing for direct measurement of amounts and composition of nutrients released into the air. Results from the field measurements show extractable NH_4^+ to increase following fire with moisture content for some fuel types but we did not see similar trends for extractable NO_3^- . The combustion experiment showed that increasing fuel moisture causes increases in total N emission and NH_3, but decreases in NO_x emission. In addition, particulate emissions increased with increasing fuel moisture. Nutrient and particulate emission factors were highest for leaves especially at the higher moisture levels. Our findings help land managers to better understand how fuel moisture affects fuel consumption and nutrient release from prescription fire. This will allow managers to create management practices that maximize fuel reductions while minimizing environmental impacts within the Lake Tahoe Basin.

Technical Session Abstracts

Physical Limnology: Currents & Circulation

March 17, 2010
1:00 p.m. – 2:40 p.m.
Room 139

The Role of Physical Limnology in the Observed Distribution & Future Spread of Invasive Species in Lake Tahoe
- Geoff Schladow

Three-Dimensional Flow Fields in the Near-Shore Region of Lake Tahoe
- Francisco Rueda

The Complexities of Near-Shore Transport Phenomena at Lake Tahoe
- Kristin Reardon

Observations of Lake Tahoe's Currents from Space: Implications for Water Quality & Invasive Species Transport
- Todd Steissberg

Exchange Flow Between the Tahoe Keys & Lake Tahoe: The Implications for Spread of Invasive Species & Pollutants
- Alexa La Plante

The Role of Physical Limnology in the Observed Distribution & Future Spread of Invasive Species in Lake Tahoe

S.G. Schladow*
Tahoe Environmental Research Center, Department of Civil & Environmental Engineering, University of California, Davis

J.E. Reuter
Tahoe Environmental Research Center Department of Environmental Science & Policy, University of California, Davis

M. Wittmann T.E. Steissberg
Tahoe Environmental Research Center

S. Chandra
Department of Natural Resources & Environmental Sciences, University of Nevada, Reno

A. Forrest
Department of Civil Engineering, University of British Columbia

V. Schmidt N. Raineault A.C. Trembanis
Department of Geological Sciences, University of Delaware

F.J. Rueda
Instituto del Agua - Universidad de Granada

B. Laval
Department of Civil Engineering, University of British Columbia

***Tahoe Environmental Research Center, One Shields Avenue, Davis, California 95616. (530) 752-3942, gschladow@ucdavis.edu**

Funding Source: Southern Nevada Public Lands Management Act, Lahontan Regional Water Quality Control Board, Nevada State Lands, UC Davis

The spread of invasive species such as Asian clam (*Corbicula fluminea*) in Lake Tahoe is largely controlled by transport and mixing processes within the lake. The extent to which these processes can be understood will assist in the early discovery and effective control of invasive species.

Since the discovery of Asian Clam in Lake Tahoe in April, 2008, a broad range of measurement and modeling techniques have been applied, in combination with ongoing, long-term monitoring programs, to better understand the distribution and spread of invasive species.

Using a combination of satellite tracked drogues, *in situ* acoustic Doppler current profilers, autonomous underwater vehicles, high resolution thermistor chains and three-dimensional numerical models, the expected trajectories of planktonic stages of invasive species in Lake Tahoe can be described.

While efforts to prevent the introduction of invasive species remain paramount, once present in the lake it is the responsibility of management agencies to best control their spread. In part this requires a predictive ability afforded by field-validated hydrodynamic models, and in part it requires an understanding of how specific organisms are transported and the conditions under which they can reproduce and grow.

Three-Dimensional Flow Fields in the Near-Shore Region of Lake Tahoe

Francisco J. Rueda*
Instituto del Agua - Universidad de Granada

Kristin E. Reardon
Patricio Moreno
S. Geoffrey Schladow
Fabian Bombardelli
Department of Civil & Environmental Engineering,
University of California, Davis

***Instituto del Agua - Universidad de Granada, C/Ramón y Cajal, 4, 18071- Granada, SPAIN. +34 958 248018, fjrueda@ugr.es**

Funding Source: Southern Nevada Public Lands Management Act, UC Davis Eugene-Cota Robles Fellowship and National Commission for Scientific & Technological Research (Conicyt) of Chile

Three-dimensional, unsteady hydrodynamic and water quality modeling of a large lake is challenging because of computational constraints. In the near-shore region these problems are amplified because of the need for greater spatial resolution to resolve the rapidly varying bathymetry and shoreline geometry.

The three-dimensional hydrodynamic model, Si3D has been extended to include a nested-grid approach, thereby allowing fine-scale resolution to be achieved in just the near-shore region. The model has also been coupled with STWAVE, a steady state spectral wave model with the purpose of analyzing wind-wave generation and its contribution to sediment resuspension at the sloping bottom.

The combined model has been tested against sediment resuspension and current velocity data collected from the near-shore region of south Lake Tahoe in the summer and fall of 2008. Results to date show that the nested grids are capable of resolving features down to 100 m, while simultaneously reproducing the main features of the basin scale circulation in the lake. When combined with STWAVE, accurate estimates of bottom shear velocity are produced allowing for the prediction of the occurrence of sediment resuspension. A new particle-tracking routine can be used to show the transport of both fine sediment and larval stages of invasive clam species.

Having a predictive capability for three-dimensional flow processes in Lake Tahoe is an urgent need that is being fulfilled. The model, when fully developed, will allow the spread of contaminants to be predicted, and agency responses to be properly coordinated.

The Complexities of Near-Shore Transport Phenomena at Lake Tahoe

K.E. Reardon*
S.G. Schladow
F.A. Bombardelli
M. Wittmann
J.E. Reuter

***University of California, Davis, Department of Civil & Environmental Engineering, One Shields Avenue, 2001 Engineering III, Davis, California 95616. (530) 752-0586, kkeastman@ucdavis.edu**

Funding and support: Southern Nevada Public Lands Management Act, Eugene-Cota Robles Fellowship (2007-2009), NortekUSA, California Department of Water Resources, and US Geological Survey

Transport phenomena in natural systems are notoriously complex. The near-shore environment at Lake Tahoe is especially so owing to the shallow water depth; the spatial heterogeneity of the lake bathymetry and sediment bed, and the spatial and temporal heterogeneity of the meteorological forcing.

Two month-long observational experiments were carried out at Lake Tahoe's south shore at a water depth of between five and seven meters. The experimental periods were in summer and winter, and included the observation of 3-D currents and waves, near-bed velocity shear, near-bed particle size, near-bed dissolved oxygen and water temperature profiles.

The experiments yielded the first detailed, continuous measurements of the physics of the near-shore region at Lake Tahoe. Currents were seen to be generated from a range of forcing parameters, including general lake circulation, wind-wave response and internal waves. These latter phenomena were responsible for major oscillations in near-shore dissolved oxygen concentration.

The first results of this study have shown the near-shore to be far more complex than previously thought. However, there do appear to be a discrete number of primary mechanisms that control transport and mixing in this region. By better understanding their occurrence and impacts, it will be possible to produce a scientifically defensible monitoring program for the near-shore, and to be better able to improve water quality conditions in this critical region.

Observations of Lake Tahoe's Currents from Space: Implications for Water Quality & Invasive Species Transport

T. E. Steissberg*
Tahoe Environmental Research Center
University of California, Davis

S. G. Schladow
Tahoe Environmental Research Center
Civil & Environmental Engineering, University of California, Davis

S. J. Hook
Jet Propulsion Laboratory, California Institute of Technology

*** University of California, Davis, Tahoe Environmental Research Center, One Shields Avenue, Davis, California 95616. (530) 574-5572, tsteissberg@ucdavis.edu**

Funding Sources: NASA Earth System Science Fellowship, National Science Foundation, Southern Nevada Public Lands Management Act

Improved understanding of surface transport processes is required to predict the fate of particles and nutrients and the establishment and distribution of invasive species. Satellite observations of surface currents provide an excellent method to characterize these processes.

Satellite images acquired by several sensors were used to characterize large-scale and small-scale surface current patterns at Lake Tahoe. Temperature patterns in thermal infrared images and sun glitter patterns in visible-light images clearly delineate basin-scale gyres and meso-scale eddies.

Satellite observations have shown that the surface current structure of Lake Tahoe is highly complex, consisting of basin-scale gyres and meso-scale eddies. Meso-scale eddies have been commonly observed across the world's oceans, but minimal documentation exists of their occurrence in lakes. High-resolution satellite images have revealed that meso-scale eddies, 2 – 6 km in diameter, regularly appear in the surface layer of Lake Tahoe. These eddies occur along upwelling-induced thermal fronts and tend to form close to shore. Satellite-tracked drogues and *in situ* current measurements documented their vertical and horizontal structure, and indicated increased vertical and horizontal retention times.

Basin-scale gyres and meso-scale eddies distribute water and its constituents across the lake and around the basin. Due to their proximity to shore and interaction with other eddies and gyres, meso-scale eddies contribute to both along-shore and cross-shore transport. They can extend the time that nutrients remain in the surface layer or in particular location. The combination of along-shore and cross-shore transport can determine the patterns of invasive species establishment and distribution.

Exchange Flow Between the Tahoe Keys & Lake Tahoe: The Implications for Spread of Invasive Species & Pollutants

Alexa C. La Plante*
S. Geoffrey Schladow
William E. Feenor

***Tahoe Environmental Research Center, One Shields Avenue, Davis California 95616.**
Department of Civil & Environmental Engineering, University of California, Davis. (530) 754-8372, alexa.laplante@gmail.com

Funding Source: UC Davis Tahoe Environmental Research Center

Water can be exchanged between two interconnected water bodies through a variety of mechanisms. The exchange flow between the Tahoe Keys and Lake Tahoe was measured to assess the potential for the spread of contaminants including planktonic stages of invasive species.

Acoustic Doppler Current Profiler (ADCP) instruments were installed in each channel to collect vertical profiles of channel flow velocity and direction. Thermistor chains were deployed to measure vertical temperature profiles in each of the channels, and in-situ YSI instruments located inside and outside of the marina were used to quantify differences in water quality parameters.

Bi-layer channel exchange was observed between Lake Tahoe and the Tahoe Keys embayment. Water exchange occurs in the north-south direction, in which lower density water from the Tahoe Keys flows north into Lake Tahoe and higher density water from the lake flow into the Keys. Exchange flow velocities average 2-5 cm/sec and residence time in the Tahoe Keys marina (west basin) was estimated to be on the order of 4-7 days.

Density (temperature) driven flows occur between the Tahoe Keys and the main body of Lake Tahoe during most times of the year, with water generally flowing out of the Keys at the surface. The flow rate is sufficient to carry plant propagules, fine particles and plankton out of the Keys. Similar processes are likely to exist between other marinas and the lake, as well as between Emerald Bay and Lake Tahoe.

Technical Session Abstracts

Effects of Prescribed Burning & Forest Fuels Treatments

March 17, 2010
1:00 p.m. – 2:40 p.m.
Room 141

Assessing the Ecological Effects
of Forest Fuel Treatments in the Sierra Nevada
- Hugh Safford

The Upland Fuels Study:
Short-term Vegetation & Fuel Response to
Fuel Reduction Treatments in the Lake Tahoe Basin
- Alison Stanton

The Upland Fuels Study:
Short-Term Bird & Small Mammal Community Recovery
in the Angora Wildfire
- Patricia Manley

Vegetation & Fuel Response Ten Years After
Prescribed Fires in the California State Parks
in the Lake Tahoe Basin
- Alison Stanton

Prescribed Fire May Prevent, But Doesn't Reverse
Lodgepole Pine (*Pinus Contorta Ssp. Murrayana*) Encroachment
in Meadows of the Lake Tahoe Basin
- Erik Frenzel

Assessing the Ecological Effects of Forest Fuel Treatments in the Sierra Nevada

Hugh Safford*
USDA Forest Service, Pacific Southwest Region

David Schmidt
The Nature Conservancy, California Chapter

Chris Carlson
Department of Forestry & Conservation, University of Montana

Jens Stevens
Department of Plant Sciences, University of California, Davis

***USDA Forest Service, Pacific Southwest Region, 1323 Club Drive, Vallejo, California 94592. Department of Environmental Science & Policy, University of California, Davis, Davis, California 95616. (707) 562-8934, hughsafford@fs.fed.us**

Funding: USDA Forest Service, Pacific Southwest Region

Forest fuel treatments have been suggested as a way to protect human assets from growing fire risk, while at the same time "restoring" more natural and resilient forest conditions. However, a number of questions remain about the ancillary ecological effects of fuel treatments.

We have embarked on a collaborative effort between the Forest Service, TNC, UC-Davis, and the University of Montana, to sample completed fuel treatments in burned and unburned landscapes across the Sierra Nevada. We are assessing fuel treatment performance in the event of wildfire, and the impacts of treatments before and after fire on measures of, e.g., understory plant diversity, habitat heterogeneity, shrub cover, tree survival, rates of beetle attack, and soil litter cover.

We present preliminary results from the first two years of our study. Thus far, our results show that properly completed fuel treatments nearly always ameliorate fire effects in treated areas, and that the reduced severity of fire in these treatments also translates into a number of positive ecological outcomes on the postfire landscape.

We plan to sample more areas over the next couple of years and to continue sampling long-term in the areas we have already visited. It is still too soon to come to concrete conclusions, but our preliminary results suggest that properly completed forest fuel treatments not only reduce fire severity and preserve carbon stocks, but they can work to restore ecological conditions that have been lost over the last century due to human management.

The Upland Fuels Study: Short-Term Vegetation & Fuel Response to Fuel Reduction Treatments in the Lake Tahoe Basin

Alison E. Stanton*
BMP Ecosciences

Patricia N. Manley
USFS Pacific Southwest Research Station

Dennis D. Murphy
University of Nevada, Reno

***BMP Ecosciences, 2520 Lake Tahoe Boulevard, Suite # 8, South Lake Tahoe, California 96150.**
(530) 544-1869, alisonestanton@sbcglobal.net

Funding: Southern Nevada Public Lands Management Act, Nevada Division of State Lands Lake Tahoe License Plate Program

The effects of fuels treatments currently being implemented in the specific forest types in Lake Tahoe on vegetation and wildlife response are essentially unknown. Adaptive management requires a rapid assessment of the impacts of current prescriptions so they can be revised and refined as needed to improve forest restoration and fire safety.

In 2006, our research team began a study of vegetation and wildlife response to fuel reduction treatments in the Lake Tahoe basin. Using a Before-After-Control-Impact (BACI) design, eight paired treatment/control sites were installed on the west and east shores. As of 2009, we have sampled three mechanical cut-to-length treatments, three hand thin treatments, and one combination hand/ mechanical treatment.

Post-treatment vegetation response indicate that in general hand treatments reduced mean canopy cover by < 5% while the mechanical treatment reduced it by over 20%. The majority of trees removed in all units were small diameter and, because the treatments focused on small trees, total mean tree density declined by > 80% in both hand and mechanical treatments. In both treatment types, the average mature tree size increased slightly but not enough to change wildlife habitat classification. Surface fuel loads were not reduced significantly in any of the treatment units. Treatment effects on crown fire risk, canopy base height, and understory species richness and cover were also assessed. The results of this work, though still preliminary, suggest that hand and mechanical treatments have different effects on forest structure, wildlife habitat, and key fuel parameters, but their effects are not as predictable as expected.

The Uplands Fuels Study: Short-Term Bird & Small Mammal Community Recovery in the Angora Wildfire

Patricia N. Manley*
USFS Pacific Southwest Research Station, Davis, California

Eric Newkirk
Courtney Owens
USFS Pacific Southwest Research Station, Placerville, California

***Pacific Southwest Research Station, Sierra Nevada Research Center, 1731 Research Park Drive, Davis, California 95618. (530) 759-1719, pmanley@fs.fed.us**

Funding Source: California Tahoe Conservancy, US Army Corps of Engineers, Southern Nevada Public Lands Management Act

Fire is a natural and regular disturbance in forests that modifies forest structure and food availability for small mammals. Small mammals perform key functions in forested ecosystems, including seed caching, tunneling, and serving as primary prey for many upper trophic level species. Post-fire management strategies often include salvage logging and erosion control measures, which may reduce or enhance habitat suitability for small mammal species.

We used live trapping to characterize the small mammal community at 70 sites in and around the Angora wildfire area to investigate the effects of burn severity and post-fire management practices on the small mammal community and its role in forest ecosystem recovery. We completed sampling on 57 sites in 2008-2009, with one additional sample year planned for 2010. We present preliminary results on relationships between burn intensity, post-fire treatments, and small mammal community structure.

We found that species richness was lower at sites with high intensity burns. Although high intensity burn sites that had been salvaged were similar in species richness to those that had not been salvaged, species richness did not increase at lower intensity burns where thinning or salvage had occurred. Alternatively, small mammal abundance was not greatly affected by burn intensity; however, treatments appeared to have a positive effect on abundance at higher intensity burns. Our preliminary results suggest that there is an important interaction between burn intensity and post-fire forest management that affects the small mammal community recovery, and that post-fire management can be designed to achieve multiple recovery objectives.

Vegetation & Fuel Response Ten Years After Prescribed Fires in the California State Parks in the Lake Tahoe Basin

Alison Stanton*
BMP Ecosciences

Nancy Lozano
Tamara Sasaki
California Department of Parks & Recreation, Sierra District

***BMP Ecosciences, 2520 Lake Tahoe Boulevard Suite #8, South Lake Tahoe, California 96150.**
(415) 990-2269, alisonestanton@sbcglobal.net

Funding source: Southern Nevada Public Lands Management Act

The California Department of Parks and Recreation (CDPR) Fire Effects Monitoring Program has accumulated a 15 year dataset focused on the effects of prescribed fire in the mixed conifer forest on the west and north shore of Lake Tahoe. The long term goals of the program are to 1) re-introduce fire as a natural ecological process and 2) change stand composition in favor of Jeffery pine and sugar pine over white fir to return to pre-settlement fire regime and forest stand characteristics. Short term goals include reducing fire hazard and increasing white fir seedling mortality.

Data collection for the program has followed protocols in the Fire Monitoring Handbook (FMH), developed by the National Park Service (USDI 1992). Approximately 20 treatment plots and 7 controls have been evaluated using a new monitoring software tool called FFI (FEAT/FIREMON Integrated) (www.frames.nbii.gov/ffi). We used FFI to investigate the effects of prescribed fire on forest composition and structure, fuel loading, and understory species richness and cover.

Mean tree density declined by 46% in the year following fire, declining to 68% of pre-fire level by year ten. Snag density was nearly double pre-fire density for five years, but was 25% lower by the tenth year. A modest increase in mean tree diameter was present by year 5, but the units were still heavily dominated by small white fir 10 years later. Total surface fuel loads were dramatically reduced in the first year, but have accumulated to 75% of pre-fire loading. There did not appear to be any significant changes in understory vegetation cover. These results are informing recommendations for a streamlined fuels treatment monitoring program.

Prescribed Fire May Prevent, But Doesn't Reverse Lodgepole Pine (*Pinus Contorta Ssp. Murrayana*) Encroachment in Meadows of the Lake Tahoe Basin

Erik Frenzel*
Brian Anacker
Graduate Group in Ecology, University of California, Davis

Shana Gross
USFS, Lake Tahoe Basin Management Unit

Dr. Susan Harrison
Environmental Science & Policy, University of California, Davis

Sarah Muskopf
USFS, Lake Tahoe Basin Management Unit

Dr. Hugh Safford
USFS, Pacific Southwest Region

***Graduate Group in Ecology, University of California, Davis, P.O. Box 1513, Grass Valley, California 95945. (530) 264-6149, eafrenzel@ucdavis.edu**

Funding source: Pacific Southwest Region, USDA Forest Service Cooperative Ecosystem Studies Unit Joint Venture Agreement USDA FS # 06-JV-1105-2007-004

Anthropogenic changes in hydrology and disturbance regimes have altered meadow vegetation in the Sierra Nevada. A well-documented change is the expansion of lodgepole pine (Pinus contorta ssp. murrayana) trees into meadows formerly dominated by perennial graminoids. Managers are considering reintroducing periodic fire into meadows to kill trees and restore herbaceous species to dominance. This in-progress research examines the efficacy of prescribed fire in restoring meadows of the Lake Tahoe Basin. METHODS: Treatment and control plots were established along ecotones from meadow to forest with recent pine expansion. The size of all trees, cover of herbaceous species, fine fuel mass, and soil and water table characteristics were measured. Twenty-three plots were burned in November 2008. Weather conditions, maximum temperatures, and flame lengths were recorded. Vegetation measurements were repeated in the summer following the fire. RESULTS: Fire intensity was low as measured by maximum temperatures and flame lengths; some fuels were too sparse to carry fire. Per capita mortality rates were significantly higher in treatments than controls, although for individual trees the odds of mortality decreased with size. There was no significant change in the total coverage of herbaceous vegetation. CONCLUSIONS: Initial results indicate that low intensity prescribed fire may be insufficient to reverse lodgepole invasion due to low tree mortality among large trees. However, low intensity also prevents undesirable effects such as mortality of perennial meadow species. Thus, prescribed fire may effective at maintaining meadows following alternative restoration methods.

Technical Session Abstracts

BMP Performance & Load Reduction

March 17, 2010
1:00 p.m. – 2:40 p.m.
Room 106

Leveraging the Natural Environment as Treatment
for Highway Runoff Within the Lake Tahoe Basin
- Mark Rayback

Development of a Road Cut & Fill
Land Use Category for the
Pollutant Load Reduction Model (PLRM)
- Kevin Drake

Measuring BMP Maintenance:
Results of a Project in Douglas-Tahoe
- Jack Jacobs

Changes to Stormwater Ecotoxicity When Treating
with Chemical Coagulants Under Different Dosing Levels
- Philip Bachand

Annual Pollutant Loads
for a Small Lake Tahoe Subwatershed
- David Rios

Leveraging the Natural Environment as Treatment for Highway Runoff Within the Lake Tahoe Basin

Mark Rayback, P.E.*
Jennifer Hanson

***Wood Rodgers, Incorporated, 3301 C Street, 100-B, Sacramento, California 95816. (916) 440-8131, mrayback@woodrodgers.com**

Funding Source – California Department of Transportation

After many years of struggling to come to an agreement on the best approach for improving water quality, Caltrans and the Lahontan Regional Board have developed a process to evaluate and prioritize water quality improvements that leverages low impact development (LID) principles. This collaborative effort is documented in the NEAT Study. Prior to the NEAT Study, Caltrans designed projects to capture and treat all storm water runoff. However, it was determined that in some areas the natural environment adequately addresses storm water runoff and therefore the construction of treatment devices in these areas could cause more harm than good.

Thirty-eight miles of highway within the Tahoe Basin were evaluated. This effort resulted in the categorization of the highway into three categories:

- **NEAT (Natural Environment as Treatment) -** a segment of roadway where storm water runoff is adequately addressed by the natural environment.

- **MEAT (Modified Environment as Treatment) -** a segment of roadway where minor modifications, low impact type, or source controls measures could be implemented.

- **TREAT (Treated Environment as Treatment) -** a segment of highway where existing conditions indicate that treatment should be implemented.

The NEAT Study resulted in a GIS based tool that allows access to the agreed upon NEAT mapping prior to designing a project. This tool will be utilized during project design and allows for a consensus based approach that will allow project's to be delivered more quickly and for less cost.

Development of a Road Cut & Fill Land Use Category for the Pollutant Load Reduction Model (PLRM)

Kevin Drake*
Michael Hogan
Rachel Arst McCullough
Integrated Environmental Restoration Services

Mark Grismer
Department of LAWR-Hydrology, University of California, Davis

***Integrated Environmental Restoration Services, P.O. Box 7559, Tahoe City, California 96145.
(530) 581-4377, kdrake@ierstahoe.com**

This research project has been generously supported by a grant from Southern Nevada Public Lands Management Act

Recent modeling conducted as part of the Lake Tahoe TMDL planning effort suggests that 72% of fine sediment loading (<20-micron) to Lake Tahoe originates from urban upland source areas. Several studies, using rainfall simulation methods to determine in situ infiltration and erosion rates, have shown that steep disturbed slopes, such as road cuts, may be producing sediment yields more than an order of magnitude greater than that from relatively undisturbed or "native" soils. The "roads" land use category in the Pollutant Load Reduction Model currently generalizes pollutant loading characteristics of both paved road surfaces and adjacent cut and fill slopes, which is likely to result in considerable under-prediction of sediment loading from roads and adjacent cut/fill slope areas as well as missed opportunities to better understand and treat these persistent and long-term sources of fine sediment. In this presentation we present development of a discrete land use category for road cut/fill slopes using the most complete set of directly-measured erosion data in this region. Additionally, we define soil functional classes and develop straight-forward field assessment protocols for classifying the pollutant loading potential of cut and fill slopes at the project scale. These functional classes offer a consistent, science-based framework for evaluating load reduction opportunities for a variety of land uses. Not only do we present a synthesis of >8 years of erosion research in the Basin but also provide a practical example of how research results are being used to fill information gaps and develop tools for TMDL implementation.

Currently, the Pollutant Load Reduction Model (PLRM) is the primary tool proposed to support landowners in urbanized watershed areas in identifying sources of pollutant loading, prioritizing and implementing projects to reduce pollutant loading (primarily fine sediment), and estimating post-implementation load reductions from various projects.

Measuring BMP Maintenance: Results of a Project in Douglas-Tahoe

Jack Jacobs

Nevada Tahoe Conservation District, PO Box 915, Zephyr Cove, Nevada 89448-0915. (775) 586-1610, jjacobs@ntcd.org

Funding Sources: Nevada Division of Environmental Protection (319h Grant), Nevada Division of State Lands Lake Tahoe License Plate Grant, US Forest Service, Lake Tahoe Basin Management Unit (Southern Nevada Public Lands Management Act Grant), Douglas County, Kingsbury General Improvement District, Round Hill General Improvement District, Cave Rock General Improvement District (In-Kind and Cash Support)

Effective maintenance of stormwater system BMPs is essential to getting the expected reduction of pollutants and the design life of all assets. A program was needed to define how to measure the effectiveness of maintenance, including the condition and performance of all stormwater assets.

An inventory was conducted of stormwater system assets in Douglas-Tahoe to catalog age, location, ownership, and other features of each asset. GIS Mapping was then performed to collect all asset data, linking the graphical features of the map with important design and condition data. Finally, an inspection and maintenance program was developed with a common scoring system to rate condition and performance.

A complete asset inventory with GIS mapping and an Operations and Maintenance Handbook was prepared to initiate measurement of BMP maintenance. This data is expected to be useful in development of the Tahoe Regional Stormwater Monitoring Program (RSWMP) and confirming requirements by funding agencies that owners are maintaining their assets.

This project established an inspection and maintenance program for Douglas-Tahoe that can be applied in other jurisdictions. Washoe County and NDOT have proposed to complete similar work. This scorecard approach could show the scores of all stormwater assets in the basin and the trend by each jurisdiction. It is expected these trends will correlate with actual measured performance. Alan Heyvaert has stated this approach would provide the type of information on water quality infrastructure that will be needed ultimately for successful implementation of the RSWMP.

Changes to Stormwater Ecotoxicity When Treating With Chemical Coagulants Under Different Dosing Levels

P.A.M. Bachand*
S.M. Bachand
Bachand & Associates

S.E. Lopus
Bachand & Associates
University of California, Berkeley, Demography

A. Heyvaert
Desert Research Institute

I. Werner
S.J. Teh
University of California, Davis, School of Veterinary Medicine, Department of Anatomy, Physiology & Cell Biology, Aquatic Toxicology Program

J.E. Reuter
Department of Environmental Science, Tahoe Environmental Research Center, University of California at Davis

***Bachand & Associates, Davis, California.**

In recent decades, the transport of stormwater-associated fine particles and phosphorus into Lake Tahoe has led to decreased water clarity and related ecological changes. Polyaluminum chloride coagulants (PACs) have shown great promise in removing these constituents from stormwater before it enters the lake. Settling column studies show particulate removal rates greatly increase through precipitation and flocculent aggregation. However, the potential risks of coagulant treatment to aquatic organisms are not well understood. To assess these risks, we used the USEPA 3-species toxicity test through growth of green algae (*Selenastrum capricornutum*), zooplankton (waterflea, *Ceriodaphnia dubia*) mortality; and a nonstandard fish test using Japanese medaka (*Oryzias latipes*) to test raw and treated stormwaters. In our first study, stormwater samples (collected from different urbanized areas in May 2004) were treated with three different coagulants (JC1720, PAX-XL9, Sumalchlor50) at levels determined with jar testing for solids removal. Raw stormwaters were toxic to algae and fathead minnows (mortality). Treatment with coagulants increased toxicity to zooplankton (reproduction) and had no consistent effects on the other toxicity metrics. In our second study, we focused on the effects from different dosing levels. We investigated stormwater and coagulant toxicity under non-dosed, optimally-dosed, and over-dosed conditions using the EPA 3-species test. Stormwater samples were collected from three sites during a 2005 spring snowmelt runoff event. Samples were dosed with two different coagulants (a chitosan and a PAC) at levels optimized with a streaming current detector (SCD). Non-treated highway runoff was toxic to zooplankton and fish. Optimal coagulant dosing decreased some toxicity metrics, increasing algal growth and reducing zooplankton toxicity. Overdosing at two- and three-times the optimal level of a PAC increased some toxicity metrics, decreasing zooplankton reproduction and increasing fish mortality. PAC-related toxicity was correlated with increasing total unfiltered aluminum and decreasing alkalinity, pH, and .DOC. Because of toxicity risks, we recommend keeping PAC coagulant dosing at or below optimal levels and using accurate methods, such as the SCD, to determine those levels.

Annual Pollutant Loads for a Small Lake Tahoe Subwatershed

David Rios*
Dr. Sudeep Chandra
Department of Natural Resources and Environmental Science,
University of Nevada, Reno

Dr. Alan Heyvaert
Desert Research Institute

***University of Nevada, Reno, Department of Natural Resources & Environmental Science, 1000 Valley Road, Mail Stop 186, Reno, Nevada 89512. (775) 784-6646, divadrois@gmail.com**

Funding source: Placer County

Lake Tahoe is famous for its crystal clear water, yet during the last forty years this clarity has been threatened. Researchers have documented a .27 m yr^{-1} decline in lake transparency and a doubling of lake primary productivity since measurements began in the mid 1960s. In response to these findings, the Tahoe Regional Planning Agency (TRPA) is implementing a regional restoration effort to improve, among other resources, water quality in Lake Tahoe. Restoration is currently underway within Barton Creek, a small subwatershed on the north shore of Lake Tahoe.

Using 18 months of stormwater monitoring data including continuous streamflow and monthly storm event sampling, we estimated annual pollutant loads for Barton Creek using a simple scaling method. These loads were compared with ten monitoring sites from the Lake Tahoe Interagency Monitoring Program (LTIMP). We developed a land use GIS to identify important variables that may be driving pollutant loads. Statistical analysis was used to find significant regression models that explain the variance in pollutant loads.

Barton Creek had the largest orthophosphate and ammonium median monthly yield compared with the ten LTIMP sites. Our simple constant concentration scaling method for estimating annual pollutant loads provided reasonable estimates and Barton Creek ranked 5th overall out of the ten LTIMP sites. Significant simple regression models were found relating the percent impervious area to three primary pollutants (orthophosphate, dissolved inorganic nitrogen, and suspended sediment).

Small Lake Tahoe subwatersheds like Barton Creek may contribute significant pollutant loads to Lake Tahoe. Simple scaling methods using constant concentrations can provide reasonable annual pollutant load estimates. The percent impervious area within subwatersheds is an important driver of annual pollutant loads.

Technical Session Abstracts

Physical & Chemical Dimensions of Tahoe Water Quality

March 17, 2010
3:00 p.m. – 4:20 p.m.
Room 139

Constructing a Multi-Decadal Record
of Lake Tahoe Surface Temperatures
from Satellite Data
- Philipp Schneider

In-Situ Optical Measurements to Determine
Suspended Particle Composition in Lake Tahoe:
Organic vs. Inorganic Particles
- Stephen Andrews

Temporal Variations in Fine Particle Distributions at Lake Tahoe:
Trends & Implications for Clarity
- Daniel Nover

Monitoring Gasoline & Gasoline-Derived Compounds
for the Shorezone Water-Quality Monitoring Program
in Lake Tahoe, California & Nevada
- Timothy G. Rowe

Constructing a Multi-Decadal Record of Lake Tahoe Surface Temperatures from Satellite Data

P. Schneider*
S. J. Hook
R. Radocinski
G. C. Hulley
NASA Jet Propulsion Laboratory, California Institute of Technology

G. K. Corlett
Department of Physics & Astronomy, University of Leicester

S. G. Schladow
T. E. Steissberg
Tahoe Environmental Research Center, University of California at Davis

***NASA Jet Propulsion Laboratory, California Institute of Technology, Mail Stop 183-501, 4800 Oak Grove Drive, Pasadena, California 91109. (805) 259-8659, philipp.schneider@jpl.nasa.gov**

Funding sources: The research described in this paper was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics & Space Administration. The authors wish to acknowledge funding by the NASA Earth Observing System and support from ESA in acquiring the ATSR data.

On a global scale, in situ measurements of lake water temperature are sparse, infrequent, and inconsistent. Observations from space can be used to overcome this problem. A nearly 30-year global archive of satellite thermal infrared imagery is currently available from multiple sensor platforms. Using such data, highly accurate water surface temperature retrievals can be obtained several times per day, depending on the availability of cloud-free scenes. In this contribution, we present methodology to derive a consistent and homogeneous record of water surface temperature for large lakes worldwide and for Lake Tahoe in particular. The results indicate that 1) water surface temperature can be derived from the satellite data with an accuracy of up to 0.2 K when validated against in situ data measured at four buoys situated in the center of Lake Tahoe, that 2) continuous and homogeneous time series of Lake Tahoe surface water temperature from 1981 to present can be obtained using the satellite thermal infrared data, and finally that 3) the mean summertime nighttime temperatures in the center of Lake Tahoe have been increasing at an average rate of 0.13±0.02 K/yr since 1992, which is approximately double the rate of regional air temperature increase. Such accurate and continuous time series of lake water temperature are useful for a variety of applications: They complement existing in situ observations, can be used used to analyze decadal trends in surface water temperature and relate such changes to regional climate change, and can provide an additional input to geophysical lake models.

In-Situ Optical Measurements to Determine Suspended Particle Composition in Lake Tahoe: Organic vs. Inorganic Particles

Stephen Andrews*
Daniel M. Nover
S. Geoffrey Schladow
John E. Reuter

***Tahoe Environmental Research Center, Department of Civil & Environmental Engineering, University of California, Davis. (530) 220-5697, swandrews@ucdavis.edu**

Funding Sources: University of California, Davis; US Environmental Protection Agency; Southern Nevada Public Lands Management Act

The particles suspended in Lake Tahoe vary greatly in size and composition, from small bacteria and inorganic mineral grains to midsize diatoms to large, heterogeneous flocs. Accurate determination of the size distribution and bulk particle composition, which is known to shift between dominantly inorganic particles during the spring and summer snowmelt to dominantly organic particles during the fall and winter, is essential in studying ecosystem function and organizing monitoring and management programs for lake clarity. Previously, particle composition has been determined using time consuming lab methods, such as X-ray fluorescence spectroscopy or flow cytometry, for which sample sizes are small and particle aggregation, breakup, or organic growth may take place during sample transportation and handling. In this study, we use measurements from two in-situ optical instruments, the LISST particle size analyzer and the HydroScat backscatter sensor, to predict the dominant particle composition (organic vs. inorganic) using the particle index of refraction as a proxy. Results from two sampling dates, one during high thermal stratification conditions in September 2009 and one during low stratification in November 2009, indicate a general dominance by organic particles, as is typical of the time of year, but show variation with depth. The method shows promise as a quick and simple way of determining bulk particle composition, and may be integrated into the lake's long-term monitoring program.

Temporal Variations in Fine Particle Distributions at Lake Tahoe: Trends & Implications for Clarity

Daniel M. Nover*
Stephen Andrews
S. Geoffrey Schladow
Tahoe Environmental Research Center
Department of Civil and Environmental Engineering,
University of California, Davis

Travis Schuler
Department of Civil & Environmental Engineering,
University of California, Davis

John E. Reuter
Tahoe Environmental Research Center
Department of Environmental Science & Policy,
University of California, Davis

***University of California, Davis, Tahoe Environmental Research Center, One Shields Avenue, Davis, California 95616. dmnover@gmail.com**

Funding Sources: UC Davis, US Environmental Protection Agency, National Science Foundation, Southern Nevada Public Lands Management Act

Fine particles are the basis of the Total Maximum Daily Load (TMDL) for clarity at Lake Tahoe. How can we monitor these particles in the long term? How do concentrations and distributions of these particles change in time and what do existing long term monitoring data tell us about particles and their relationship to clarity?

UC Davis has collected fine particle data from two long term monitoring sites at Lake Tahoe for the last 10 years. These data have been systematically analyzed in order to understand seasonal and intra-annual trends in the fine particles that influence lake water clarity. Additionally, several indices of fine particle distribution and concentration are considered for predicting Secchi depth.

Clear seasonal and intra-annual trends in particle concentration are evident in the data. Spikes in fine particle concentration can be seen during the spring/summer and likely correspond to the spring snowmelt period. Particle concentrations reach a distinct low in winter, when flow to the lake is at a minimum and productivity is reduced. In addition to seasonal variations in particle concentration, intra-annual variations have a pronounced impact on the particle concentrations. During extremely wet years particle concentrations peak, while they tend to decline during extremely dry years. These macro-climatic impacts appear to dominate seasonal trends in particle concentrations.

Despite limitations in the temporal resolution of these data, they highlight important annual and seasonal trends in fine particle dynamics and underscores important drivers of fine particles in the Lake Tahoe Basin.

Monitoring Gasoline & Gasoline-Derived Compounds for the Shorezone Water-Quality Monitoring Program in Lake Tahoe, California & Nevada

Timothy G. Rowe

US Geological Survey, Nevada Water Science Center, 2730 North Deer Run Road, Carson City, Nevada 89701. (775) 887-7627, tgrowe@usgs.gov

The Tahoe Regional Planning Agency in October 2008 adopted the Lake Tahoe Shorezone Ordinance Amendments allowing possible construction of new buoys and piers, as long as established environmental thresholds are met. Baseline water-quality data are needed to determine if these possible additional shorezone structures result in higher emissions due to increased boat traffic. The Shorezone Water-Quality Monitoring Program (SWQMP) was designed to determine the baseline water quality conditions and if Outstanding National Resource Water standards will be exceeded. SWQMP objectives are to; (1) determine a wider baseline of concentrations of gasoline and gasoline-derived compounds (BTEX and PAHs), prior to any shorezone changes, where historical water-quality data are limited, (2) understand temporal and spatial changes in water quality in the lake, and (3) to determine if mitigation measures are effective.

The number of sampling locations increased from 9 to 20 sites to include areas of possible change in shorezone development and boat traffic. BTEX samples were collected in areas of low, moderate, and high boat traffic around Lake Tahoe before, during, and after the summer boating season. Semi-permeable membrane devices (SPMDs) were used to provide a time-integrated concentration of gasoline-derived compounds (PAHs) at 10 of the 20 locations over a 30 to 34-day period of high recreation.

Preliminary results show the highest BTEX concentrations (0.27 micro grams per liter (µg/L)) were present in samples collected at higher boat-use areas. The lowest concentrations (<0.02 µg/L) were present in samples collected during the pre-season, when boating activity is minimal, and in lower boat-use areas.

Technical Session Abstracts

Managing Forest Vegetation Communities

March 17, 2010
3:00 p.m. – 4:20 p.m.
Room 141

Tree Health Within the Nevada Portion of the Lake Tahoe Basin:
Interactions with Fuel Management Treatments
- Isabel Munck

Managing Slash in Pine Dominated Stands
to Minimize Residual Tree Mortality
Attributed to Bark Beetle Attack
- Christopher Fettig

The Effects of Land-Use, a Non-Native Pathogen &
Environmental Heterogeneity on the Population Dynamics
of Three White Pine Species in the Lake Tahoe Basin
- Patricia Maloney

The Role of Resistance to White Pine Blister Rust
in Restoration of the White Pine Species
in the Lake Tahoe Basin
- Detlev Vogler

Tree Health Within the Nevada Portion of the Lake Tahoe Basin: Interactions with Fuel Management Treatments

Isabel Munck*
Robert Nowak
Peter Weisberg
Yuanchao Fan

***University of Nevada, Department of Natural Resources & Environmental Science, Reno, Mail Stop 370, Reno, Nevada 89557. (775) 682-6554, imunck@cabnr.unr.edu**

Funding source: Nevada Division of State Lands Lake Tahoe License Plate Program

To reduce the risk of wildfire, wide scale fuel reduction and forest restoration projects are being implemented in the Lake Tahoe Basin. Unfortunately, little quantitative data is available on the incidence and severity of tree diseases and insects within the Basin, and scientific knowledge on how these forest treatments impact tree health is minimal for the Tahoe Basin. Therefore, our objective was to quantify changes in incidence and severity of tree diseases, insects, and other damaging agents in areas that have been treated by Nevada Division of Forestry to reduce fuels and restore forest health. During 2008-2009, 70 permanent, 30 m x 30 m square plots were established. Thirty three plots are within treated areas and 37 plots were outside of treated areas (controls). As expected, tree density and the proportion of dead trees in treated plots were less than in control plots. The incidence of damaging agents was not different in treated plots compared to control plots, but the severity of damage was less in treated plots than in control plots. The health status of trees varied with location and treatment type. In three locations (of seven) the health status was better for trees in treated plots compared to trees in control plots. For one location, where trees were charred by a prescribed burn, the health status was worse for trees in treated plots compared to trees in control plots. In some locations, damage from forest treatments to residual trees may conflict with restoration goals.

Managing Slash in Pine Dominated Stands to Minimize Residual Tree Mortality Attributed to Bark Beetle Attack

Christopher J. Fettig*
Christopher J. Hayes
Stephen R. McKelvey
USDA Forest Service, Pacific Southwest Research Station

Tom DeGomez
University of Arizona

Joel D. McMillin
John A. Anhold
USDA Forest Service, Forest Health Protection

*** USDA Forest Service, Pacific Southwest Research Station, 1731 Research Park Drive, Davis, California 95618. cfettig@fs.fed.us**

In the western U.S., thinning is advocated by land managers as a means of reducing fuel loads, improving residual tree growth, and as a preventive measure for reducing subsequent amounts of bark beetle-caused tree mortality. Due to lack of developed markets for small diameter trees, large amounts of downed material (i.e., slash) is created and left in the field. This material, if left on the ground, has inherent value and ecological functions, while at the same time creates host material for many bark beetle species, specifically those in the genus Ips. Large Ips populations having successfully bred in slash can attack residual trees and cause unwanted tree mortality. This presentation details our review of the current literature and presents treatment options and guidelines for managing slash to minimize bark beetle activity in response to thinning treatments. We focus on ponderosa pine, but also offer guidelines that apply to other stand types, specifically Eastside pine. While the primary focus is on engraver beetles (Ips spp.), we include information on other bark beetle species associated with slash. Slash treatment options addressed here include green chaining, piling, direct removal, solarization, burying, cutting to short lengths, lop-and–scatter, chipping, and chemical treatments. We conclude that forest managers in the Tahoe Basin and throughout much of the western U.S. can minimize residual tree mortality attributed to bark beetle attack by creating slash when beetle activity is low and by implementing prompt slash treatments.

The Effects of Land-Use, a Non-Native Pathogen & Environmental Heterogeneity on the Population Dynamics of Three White Pine Species in the Lake Tahoe Basin

Patricia Maloney*
Detlev Vogler
Camille Jensen
Annette Delfino-Mix

***Department of Plant Pathology & Tahoe Environmental Research Center, University of California, Davis, One Shields Avenue, Davis, California 95616. (530) 546 3014, pemaloney@ucdavis.edu**

Funding for this work has been received from the Southern Nevada Public Lands Management Act and the Nevada Division of State Lands Lake Tahoe License Plate Program.

High levels of the non-native pathogen *Cronartium ribicola* (causal agent of white pine blister rust, WPBR), are found throughout the LTBMU. The highest levels of WPBR are found on whitebark pine, the dominant species in subalpine forests. On average 35% (range:1-64%) of all whitebark pines are WPBR-infected. Average WPBR-incidence on western white pine is 12% (range:0-44%) and 17% (range:0-48%) for sugar pine, with variation among sites. In some sugar pine stands the interaction of fire suppression and stand densification, along with high levels of WPBR, have resulted in a reverse J-shaped population structure. In upper montane forests, western white pine stands with high WPBR-incidence are also experiencing moderate to high levels of mountain pine beetle-mediated mortality, across all size classes of individuals. One of the primary and negative effects of WPBR, on larger individuals, is infection and mortality of cone-bearing branches, with trees essentially becoming reproductive dead-ends. This is most apparent in whitebark pine populations, where there is a strong and negative correlation (r^2=0.48) between WPBR-incidence and number of seedlings in a population. Populations exhibiting signs of decline due to WPBR (as mentioned above) will be recommended for restoration. However, there are representative populations for each species, across elevation zones, that appear stable, resilient, and genetically diverse; even given pressures of historical land-use, a non-native pathogen and climate-driven outbreaks of mountain pine beetle. Preliminary data on the amount and landscape patterns of adaptive genetic variation in white pine species will also be discussed.

The Role of Resistance to White Pine Blister Rust in Restoration of the White Pine Species in the Lake Tahoe Basin

Detlev Vogler*
Annette Delfino-Mix
USDA, Forest Service, Pacific Southwest Research Station,
Institute of Forest Genetics

Patricia Maloney
Department of Plant Pathology & Tahoe Environmental Research Center,
University of California, Davis

***USDA, Forest Service, Pacific Southwest Research Station, Institute of Forest Genetics, 2480 Carson Road, Placerville, California 95667-5107. (530) 621-6881, dvogler@fs.fed.us**

Funding source: Southern Nevada Public Lands Management Act, and from the Forest Service, Region Five, State & Private Forestry, Special Technology Development Program (2005-2009), have supported this research.

The white pine blister rust fungus, *Cronartium ribicola*, infects sugar, western white, and whitebark pine throughout the Basin. On average, 35% of whitebark pine are infected, with lower though significant infection of sugar and western white pine (17 and 12%, respectively). Traditionally, planting resistant seedlings has been the most practical approach to counteracting effects of blister rust in timber-production forests. In the Basin, ecosystem and esthetic values are paramount, and it is unlikely there will be extensive plantings of resistant seedlings in future. For whitebark, options for restoration are more restrictive: mechanisms and inheritance of resistance to blister rust are poorly understood, and successful planting and subsequent survival are hampered by the harsh, rocky terrain. Nevertheless, we have embarked upon intensive research into resistance to blister rust in all three Tahoe white pines: i) with the Placerville Nursery, we are screening large collections of sugar and western white pine for a needle-reaction trait that confers host immunity and is simply inherited; and, ii) we are testing whitebark pine, which is not known to have the needle-reaction trait, to investigate other potential resistance mechanisms. If planting resistant stock is not feasible, why continue to research the geographic distribution of resistance in these species? Because we assert that understanding phenotypic and genomic determinants of resistance, and mapping their distributions, will contribute to more informed management, since it yields insights into forest structure that go beyond thinning criteria based solely upon spacing and species composition, to include adaptive genetic trait data as well.

Technical Session Abstracts

Air Quality & Road Dust

March 17, 2010
3:00 p.m. – 4:20 p.m.
Room 106

Sources of Ambient Particulate Matter
in the Lake Tahoe Basin
- Alan Gertler

Deposition Studies of Vehicle-Generated PM
Near Highway 50 in Lake Tahoe
- Dongzi Zhu

Overview of Road Dust Impacts in the Lake Tahoe Basin,
Including Winter Sanding & Salting
- David Barnes

Preliminary Results of the Pilot Sweeper Study
- Scott Brown

Sources of Ambient Particulate Matter in the Lake Tahoe Basin

Johann Engelbrecht*
Alan Gertler
Desert Research Institute

Tony VanCuren
California Air Resources Board

***Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada 89551. (775) 674-7027, Johann.Englebrecht@dri.edu**

Funding source: USDA Forest Service Southern Nevada Public Lands Management Act

Deposition of ambient particulate matter (PM) has been implicated as a major source of nitrogen (N), phosphorus (P) and sediment to Lake Tahoe. Therefore, knowledge of the sources contributing to PM is crucial to develop approaches to reduce the impact of atmospheric deposition on water quality in the lake.

Ambient and source samples were previously collected and analyzed as part of the "Lake Tahoe Atmospheric Deposition Study" and "Lake Tahoe Source Characterization Study". To close the gap between these two earlier studies and determine the sources contributing to PM levels in the basin, the Lake Tahoe Source Attribution Study (LTSAS) was undertaken.
Based on the source apportionment results, we observed the following:

- Re-suspended paved road dust was the major source of PM_{10} in the basin.
- Wood burning, with possible contributions from local wildfires, was the major source of $PM_{2.5}$ during the fall and winter months.
- After wood burning, mobile source emissions are major contributors to $PM_{2.5}$.
- There was little evidence of emissions from wildfires in or outside the Tahoe basin.
- It appears as if the majority of the coarse PM fraction (PM_c) deposited prior to reaching the buoy locations.

To control atmospheric PM_{10} deposition to the lake, it is necessary to reduce the amount of resuspended road dust. This is also the fraction with the greatest amount of phosphorous (P). Reductions in wood burning and mobile source tailpipe emissions will lead to a reduction in $PM_{2.5}$ levels, which impacts visibility.

Deposition Studies of Vehicle-Generated PM Near Highway 50 in Lake Tahoe

Dongzi Zhu*
Hampden D. Kuhns
John A. Gillies
Alan W. Gertler
Desert Research Institute, Reno, Nevada

Vicken Etyemezian
Desert Research Institute, Las Vegas, Nevada

Scott Brown
Nevada Tahoe Conservation District

***Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada 89512. (775) 674-7086, zhu@dri.edu**

Funding: This work was funded by the USDA via a grant through the Southern Nevada Public Lands Management Act.

Fugitive road-dust emissions were a major source of PM_{10} in the Lake Tahoe Basin, transport and deposition processes of these particles near roadways are not well understood. Empirical measurements of aerosol deposition velocities were calculated based on changes in aerosol size distribution with distance from a road. Aerosol concentrations beside Highway 50 near Zephyr Cove in Lake Tahoe roadways were measured along with local windspeed and direction using four battery powered sampling systems. During sampling periods in November 2008 and February 2009, daytime winds were observed onshore upslope, nighttime winds were offshore downslope. Offshore winds after sunset and before sunrise transport near-shore road dust emissions over the Lake. Highest PM number concentrations were recorded by downwind samplers after a winter snow event and increase in the daytime with traffic. Ambient levels of particles > 2.5 um in diameter are primarily related to road traffic whereas the smallest particle (0.3 to 0.5 μm) are more homogenously dispersed on both sides of the road. Spatial PM concentration profiles indicate coarse (2.5 to 10 μm) particles concentrations depleted to ~50% of their 5 m downwind levels at 30 m downwind site and to ~18% at 100 m downwind site. Smallest particles (0.3 to 0.5 um) depleted to ~95% at 30 m downwind and to ~88% at 100 m downwind site. Deposition velocities were generally less than detectable limits (1 cm/s) for particles less than 2 μm but increased to 8 cm/s for particles greater than 15 um, deposition velocities decrease with denser vegetation.

Overview of Road Dust Impacts in the Lake Tahoe Basin, Including Winter Sanding & Salting

David E. Barnes*
Thomas A. Cahill
Geoffrey Schladow
Tahoe Environmental Research Center

***University of California, Davis, John Muir Institute of the Environment, One Shields Avenue, Davis, California 95616. (530) 752-1120, debarnes@ucdavis.edu**

Funding provided by Caltrans Contract 43A0168, TO #12 and Southern Nevada Public Lands Management Act, US Environmental Protection Agency

The effects of re-suspended dust from roadways in the basin, is an important consideration when managing the influences on Lake Tahoe water clarity. Road sanding and salting in winter is particularly important. We have studied Tahoe basin aerosols over the course of several studies and many years, including the influence of highway derived particles affected by Caltrans winter operations, the TRPA study at South Lake Tahoe during 2001 and 2002, ARB's LTAD 2003, Caltrans 2004-2005, and SNPLMA 2007-2008.

Our studies used size, time, and compositional analysis of aerosols near Highway 50 in the south and recently near the Tahoe Gatekeeper's Museum at Tahoe City. In all cases, samplers were run for extended periods of time, typically 3 months, with analysis every 3 hours in 8 size modes, from 35 μm to 0.09 μm. Elemental analysis was by S-XRF, which covers elements from sodium to around zirconium, plus lead.

The results show that it is the melting and drying phases, after sand and salt applications, that cause the aerosols to form and transport over the lake. Modifications of the sand mixture to low phosphorus materials and a material called Ice-Slicer™ sharply reduced the phosphorus input into the lake by about a factor of 4. However, insoluble particulate matter control requires prompt removal of materials after application, and careful control of run-off onto road surfaces.

Preliminary Results of the Pilot Sweeper Study

Scott Brown*
NTCD

Dr. Rick Susfalk
Desert Research Institute

***NTCD, P.O. Box 915, Zephyr Cove, Nevada 89448. (775) 586-1610 x31, sbrown@ntcd.org**

Funders: Nevada Division of State Lands Lake Tahoe License Plate program; USFS CURTEM Grant

The effectiveness of a dustless street sweeper to remove fine sediment from a road surface was evaluated in the Tahoe Basin. Paired catchments on Village Blvd. in Incline Village, NV were sampled for sediment mass, particle size distribution, and nutrient mass during the winter of 2008/09 and continuing during the winter of 09/10. A residential vacuum cleaner was used to estimate the mass and size distribution of sediment on the road before and after the street sweeper had swept the road. The mass and size distribution of sediment collected by the street sweeper was evaluated, along with the material captured by the drop inlet catch basins and in the stormwater runoff. The preliminary results show 200 µm is the most prevalent size fraction collected by the vacuum, the sweeper, and the catch basins. Approximately 10% of the mass from these dry samples were 20 µm or less, whereas 78% of the sediment in stormwater runoff was less than 20 µm. The total mass collected by the vacuum, catch basin, and runoff samples indicate over 5,000 pounds of sediment was removed from the road, however, only 550 pounds of sand was applied. The additional material originated, in part, from pine needles and other non-geologic material, but also probably from breakdown of the road surface and vehicle tires. We calculate that 1 mm of wear from the 4 wheel ruts will generate about 6,000 pounds of sediment. To validate our theory, DRI will soon analyze the sediment to determine the origin.

Poster Session Abstracts

March 16, 2010
5:00 p.m. – 7:00 p.m.

Restoring Stand Structures to Promote Sugar Pine (*Pinus Lambertiana*) Regeneration & Recruitment in the Lake Tahoe Basin, CA & NV
- Natalie Angell & Kristen Waring

Predicting the Future Spread of Invasive Plants with Climate Change
- Elizabeth D. Brusati, D. Johnson & J.M. DiTomaso

Effects of Pile Burning in the Tahoe Basin on Soil & Water Quality
- Matt Busse, K. Hubert, C. Shestak, & S. Overby

Effects of Hillslope Heterogeneity on Late Season Groundwater Discharge: Investigations Using a Coupled Groundwater-Surface Water Model
- Wes Christensen & Graham Fogg

A Monitoring Strategy for Riparian Forest Restoration
- Christa Dagley, J-P Berrill & V. Lyon

Best Management Practices & the Influence on the Value of Affected Homes
- Alison F. Davis & Wuyang Hu

Results From a Survey to Assess the Perceptions, Value & Goals of the Tahoe Science Consortium
- Jill C. Falman & Zachary P. Hymanson

Linking On-Shore & Near-Shore Processes: Near-Shore Water Quality Monitoring Buoy at Lake Tahoe
- Brian Fitzgerald, A. Heyvaert, T. Mihevc, R.B. Susfalk & K. Taylor

Differential Tolerances to UVR & Fluoranthene Exposure: Comparisons Between Native & Invasive Fish Species of Lake Tahoe (CA/NV)
- Amanda K. Gevertz, J.T. Oris, A.J. Tucker & C.E. Williamson

Five Years of Vegetation Monitoring at Grass Lake Research Natural Area
- Shana Gross & Stuart Osbrack

Ski Slope Native Plant Revegetation Study
- Shana Gross, Jennifer Burt, Kathleen Nelson, Susie Urie, Matt Brown, Deveree Kopp & Elizabeth Bergstrom

Mountain Pine Beetle (*Dendroctonus Ponderosae*) Dynamics at Three Elevation Zones in the Lake Tahoe Region
- Camille E. Jensen, B.J. Bentz, P.E. Maloney, S.L. Smith, J.C. Vandygriff & D.R. Vogler

Explaining BMP Compliance Based on Private Landowner Characteristics
- Derek Kauneckis

The Effects of Climate Change on Alpine Bumble Bee Community Structure
- Gretchen LeBuhn & Brendan Colloran

Poster Session Abstracts

March 16, 2010
5:00 p.m. – 7:00 p.m.

Effects of Prescribed Fire & Season of Burn on Direct & Indirect Levels of Tree Mortality in Eastside Pine Forest of the Sierra Nevada
- Stephen R. McKelvey, C.J. Fettig, D.R. Cluck & S.L. Smith

A Unique Place: The Institute of Forest Genetics Research Greenhouse
- Annette Delfino Mix & Detlev Vogler

Meadow Ecosystem Response to Restoration of the Stream Channel/Meadow Surface Relationship at Cookhouse Meadow
- Craig Oehrli

Lake Tahoe Stormwater Basins: Botanical Surveys, Comparisons & a Greenhouse Trial
- David Rios, Sudeep Chandra & Alan Heyvaert

Effects of Harvesting System & Prescribed Fire on Natural Regeneration in a Jeffrey Pine Stand: Implications for Lake Tahoe Basin Forests
- Wade G. Salverson, R.F. Walker, R.M. Fecko, W.B. Frederick, W.W. Miller & D.W. Johnson

Seismic & Volcanic Hazards at Lake Tahoe
- Ken Smith & Graham Kent

The Impact of Asian Dust Aerosols on Lake Tahoe
- Jason Snyder, T.A. Cahill, C. Goldman & D. Barnes

Impact of Terrestrial Sediment Sources on Nearshore Water Quality
- Richard B. Susfalk, A. Heyvaert & B. Fitzgerald

Water Temperature & Ultraviolet Radiation Transparency Interact to Control Invasive Warm-Water Fish Establishment in Nearshore Lake Tahoe
- Andrew J. Tucker, C.E. Williamson, J.T. Oris, A.K. Gevertz, & M. Olson

Fire History of Coniferous Riparian Forests in the Lake Tahoe Basin
- Kip Van de Water

Effects of Harvesting System & Prescribed Fire on Forest Floor Vegetation in a Jeffrey Pine Stand: Implications for Lake Tahoe Basin Forests
- Roger F. Walker, W.G. Salverson, R.M. Fecko, W.B. Frederick, D.W. Johnson & W.W. Miller

Asian Clam (*Corbicula Fluminea*) Filtration & Excretion Rates: Impacts to Nutrient Cycling & Primary Productivity in Lake Tahoe
- Marion Wittmann, S. Chandra & J. Gardner

Restoring Stand Structures to Promote Sugar Pine (*Pinus Lambertiana*) Regeneration & Recruitment in the Lake Tahoe Basin, CA & NV

Natalie Angell*
Kristen Waring

***School of Forestry, Northern Arizona University, 200 East Pine Knoll Drive, Room 116, Flagstaff, Arizona 86011-5018. (406) 360-8631, nja33@nau.edu**

This research is supported by grant #08-DG-11272170-011 from the USDA Forest Service Pacific Southwest Research Station. Funding has been provided by the Bureau of Land Management through the sale of public lands as authorized by the Southern Nevada Public Land Management Act [to support restoration of Lake Tahoe].

Recent studies indicate low recruitment and regeneration rates for sugar pine (*Pinus lambertiana*) in parts of California. The decline is likely the result of extensive logging, white pine blister rust (*Cronartium ribicola*) and increased forest density resulting from fire exclusion. Since it isn't feasible in many areas to reintroduce the historic fire regime, managers need innovative ways to create conditions to promote sugar pine regeneration and growth. This study evaluates the necessary canopy closure requirements for sugar pine establishment and success in the Lake Tahoe Basin, CA and NV.

We selected fourteen sites with varied stand structures and management histories; data collection included measurements of sugar pine regeneration and canopy closure, along with basic stand characteristics assessing fuel loadings, basal area and canopy cover. Data analysis is underway to develop relationships between canopy closure and stand structure, create preliminary stocking control guidelines to manage for light in multiaged stands, evaluate fire behavior and generate management recommendations to promote sugar pine regeneration within defined fire behavior limits.

Preliminary results suggest that few differences exist in basal area and fuel loadings between treated and untreated stands. Sugar pine seedling height growth is greatest in untreated low density stands and in an untreated high density stand located in a riparian area. We believe site index is an important influence in explaining the high growth rates.

The results of this research will enable managers, particularly of California mixed-conifer forests, to enhance sugar pine establishment and growth, reduce fire hazard and restore historic structures.

Predicting the Future Spread of Invasive Plants with Climate Change

Elizabeth D. Brusati*
Doug Johnson
California Invasive Plant Council

Joseph M. DiTomaso
Department of Plant Science
University of California, Davis

***California Invasive Plant Council, 1442-A Walnut Street, #462, Berkeley, California 94709. (510) 843-3902, edbrusati@cal-ipc.org**

Funding Sources: University of California Integrated Pest Management, US Forest Service State & Private Forestry, Resources Legacy Fund

Distribution of invasive plant populations in California is dynamic, and effectively protecting native flora requires knowledge about where invasive plants are and where they may spread in the future. We determined statewide distribution of 36 invasive plants in California by surveying local resource managers. Using CLIMEX modeling software, we estimated climatic suitability for each plant throughout California based on its known distribution elsewhere in the world. Combined, these data provide information on potential future spread in the state. Next, to simulate climate change, we ran the models with a 3°C increase in annual temperature. Results indicate that overall climatic suitability in California for the 36 combined species would alter little with climate change. However, individual species may be "winners" or "losers". This information will support early detection efforts by helping local managers determine which invasive plants are most likely to move into their area. We will present examples of projected range shifts and changes in suitability for several widespread invasive plants as well as incipient invaders that show potential to expand to new areas of California. In 2009, we began to focus on additional plants of concern in the Sierra Nevada with a goal of helping local Weed Management Areas in the Tahoe Region and elsewhere guide their early detection programs to plants likely to cause the most problems in the future.

Effects of Pile Burning in the Tahoe Basin on Soil & Water Quality

Matt Busse*
Ken Hubbert
Carol Shestak
Pacific Southwest Research Station

Steve Overby
Rocky Mountain Research Station

***USDA Forest Service, 1731 Research Park Drive, Davis, California 95618. (530) 759-1721, mbusse@fs.fed.us**

Funding source: Southern Nevada Public Lands Management Act

Pile burning is a common practice for reducing fuels and fire hazard in the Tahoe Basin. Whether this treatment causes detrimental changes in soil or water quality is unclear, however. In the first year of a three-year study, we installed nearly 100 inventory plots throughout the Basin, measuring average pile size, pile density (number of piles per unit), and total ground coverage occupied by piles. Six sites were then selected for detailed study of soil and water quality response to burning. Sites were selected both within and outside of stream environmental zones, and a gradient of pile sizes was compared at each site. The soil heat pulse beneath 24 pile burns was measured using heat-recording thermocouples. Surface and subsurface water-sample collectors were also installed to quantify post-fire nitrate, phosphate, and very fine sediment movement. Mean ground coverage occupied by slash piles on the inventory plots was 10%, although several plots with high tree mortality had up to 34% ground coverage. Surface temperatures beneath burning piles reached 900oF, while lethal temperatures (> 140oF) were measured to a soil depth of 12 inches. Considerable variation in maximum temperature and heat duration was found among pile burns, which was related to differences in pile size, fuel size class, and soil moisture content at the time of burning. Preliminary findings suggest that pile burning resulted in moderate changes in soil chemical and biological quality. Monitoring of soil and water quality will continue throughout the study to determine the full extent of site changes.

Effects of Hillslope Heterogeneity on Late Season Groundwater Discharge: Investigations Using a Coupled Groundwater-Surface Water Model

Wes Christensen*
Graham Fogg

***Department of Geology, University of California, Davis, One Shields Avenue, Davis, California 95616. (801) 598-4366, wchristensen@ucdavis.edu**

Funding Source: Southern Nevada Public Lands Management Act

Groundwater discharge to wetlands helps stabilize water temperature and provides nutrients to the system. Peatlands (bogs, fens) require perennially saturated soils to prevent the decomposition of organic material. Many of these systems rely on sustained groundwater discharge to remain saturated. Recent studies have shown that hillslope subsurface heterogeneity can significantly affect the amount of storage and the timing of discharge.

Current climate projections suggest the Sierra Nevada Mountains will experience an increase in winter and spring temperatures, resulting in rain or rain on snow dominating the precipitation regime. The resulting high intensity recharge earlier in the season may significantly reduce the ability of montane hillslopes to provide groundwater during hot summer months. This in turn may lead to warmer surface water temperatures, lower nutrient availability, and drier conditions.

This study uses results from numerical simulations of variably saturated subsurface flow in heterogeneous hillslopes to investigate the potential response of groundwater in these systems to changes in precipitation. This study is part of a larger project investigating the hydrology of the Grass Lake Research Natural Area, located near Luther Pass on Highway 89. Hillslope heterogeneity is based on remote sensing data from granitic outcrops in Meiss Meadows area (due to poor bedrock exposures in the Grass Lake watershed). Geostatistical realizations that preserve the spatial distribution of permeability classes are generated using TPROGS. The storage-discharge relationships and temperature of groundwater discharge is explored using Hydrogeosphere. The results provide insight into the response of hillslope groundwater systems to changes in precipitation patterns.

A Monitoring Strategy for Riparian Forest Restoration

Christa Dagley, Ph.D.*
John-Pascal Berrill, Ph.D.
Department of Forestry & Wildland Resources, Humboldt State University

Victor Lyon
USDA Forest Service, Lake Tahoe Basin Management Unit

***Department of Forestry & Wildland Resources, Humboldt State University, 1 Harpst Street, Arcata, California 95521-8299. (707) 826-1220, christadagley@gmail.com**

We present a riparian forest monitoring strategy for the Lake Tahoe Basin. We applied the strategy to four quaking aspen forest communities that were being encroached by conifers. Large permanent 1-ha plots captured a sufficient sample size of trees to allow for rigorous analysis of change over time. Tree locations were mapped, trees tagged, and their size and condition recorded. Regeneration subplots were located systematically along transects bisecting each plot along the axis of major variation, typically running down slope and across the stream channel. At each subplot center, a 180-degree hemispherical image taken upward captured the canopy cover. In aspen stands scheduled for restoration thinning to remove competing conifers, pre-treatment assessments in summer 2009 gave baseline conditions characterizing the state of encroachment. Conifer comprised 50-90% of stocking. Conifer and aspen regeneration was abundant, but many aspen root suckers were shaded by conifers. These data may help to explain differences in response to future restoration treatments. Post-treatment assessments can be repeated at any frequency to meet monitoring or science objectives (e.g., ground-truthing of remotely-sensed data, fire behavior or hydrological studies, wildlife usage or habitat values, forest health monitoring). Stem location maps facilitate navigation within the plots and insure against loss of identifying tree tags or other confusion caused by disturbances such as natural tree fall or tree removals. Models of the probability of regeneration, regeneration abundance, and growth will be developed using tree and stand data and leaf area index or predicted understory light from processed hemispherical imagery. Regeneration data will be related to forest disturbances or change over time, and support adaptive management decision making for multiple objectives. The monitoring strategy was designed for heterogeneous species mixtures on variable riparian terrain, but could also be applied at a reduced scale in more homogenous stands outside the streamside zone.

Best Management Practices & the Influence on the Value of Affected Homes

Alison F. Davis*
Wuyang Hu

***Department of Agricultural Economics, University of Kentucky, 411 CE Barnhart Building, Lexington, Kentucky 40546. (859) 257-7260, Alison.davis@uky.edu**

This study explores the influence of mandated best management practices on housing prices in Lake Tahoe. BMPs were mandated to protect the water quality of the lake. However, the purpose of this study was to determine the significance of BMP's mandated for homeowners around the area.

Market transaction data were collected from Washoe and Douglas counties in Nevada as well as two counties in California. We collected data describing the structural properties of each house as well as environmental data that the TRPA provided to us. As a result, we determined that several factors influenced the market price of homes in Lake Tahoe. We found that the priority zone a house was located in significantly impacted the price. In addition, other variables that could determine the likelihood of receiving a certificate also impacted housing prices, such as soil permeability, distance to shore zone, elevation, etc.

These results can first be used to accurately value properties around Lake Tahoe. In addition, the results suggest that the mandated BMP's while important to maintaining the environmental conditions around the lake are not without cost to property owners. We found that the priority zone a house was located in significantly impacted the price.

If the current specifications of a home will not allow for a certificate to be administered homeowners will not be able to remodel or build thus decreasing the potential value of their home.

Results from a Survey to Assess the Perceptions, Value & Goals of the Tahoe Science Consortium

Jill C. Falman*
Zachary P. Hymanson

***Tahoe Science Consortium, 291 Country Club Drive, Incline Village, Nevada 89451. (775) 881-7566, jcfalman@ucdavis.edu**

A web-based survey was conducted between November and December 2008, to obtain input on the perceptions, value, and goals of the Tahoe Science Consortium (TSC). Through its 17 questions, the survey provided an opportunity for individual input on the appropriateness of the TSC's primary objective and to assess the value of TSC efforts as perceived by a variety of individuals working in the Tahoe Basin. The survey also included a question about potential programmatic goals the TSC could pursue in the future. Approximately 450 individuals were invited to complete the survey via the internet, of which 140 individuals responded to the TSC survey and identified themselves as associated with one of seven affiliations: Federal Government, State Government, Regional Government, Local Government, Environmental Group, Business/Property Rights Group, and Research Scientist. Results from the survey were compiled, analyzed, and published into a survey report: *Results from a survey to assess the perceptions, value, and goals of the Tahoe Science Consortium.* Overall responses indicate the TSC needs to better communicate services it provides and disseminate scientific data and information to all sectors in the Tahoe Basin (e.g., the public, stakeholders, project implementers, or government agencies). As a result of the need to augment communication strategies, the TSC plans to use the survey report to guide the development of a strategic plan for the TSC, inclusive of the development of a science communication strategy. The results will also be used to guide the TSC's efforts to maintain and improve its value.

Linking On-Shore & Near-Shore Processes: Near-Shore Water Quality Monitoring Buoy at Lake Tahoe

Brian Fitzgerald*
Alan Heyvaert
Todd Mihevc
Richard B. Susfalk
Kendrick Taylor

***Division of Hydrologic Sciences, Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada 89512. (775) 673-7453, rick.susfalk@dri.edu**

Funding Source: Nevada Division of State Lands Lake Tahoe License Plate Program

Lake Tahoe's nearshore environment provides habitat for aquatic species and is the area where most visitors and residents directly interact with the lake. Challenges to the quality of the nearshore have increased over time, but their impacts have not been routinely assessed due to the lack of a consistent monitoring program capable of delineating meaningful long-term changes. The objective of this project was to develop and optimize operations of a pilot nearshore water quality buoy meeting the needs of basin managers and scientists.

The buoy was deployed 40 m off of Third Creek to assess the impact that the creek had on near-shore water quality for seven months in 2008. Biofouling occurred primarily during summer and early fall. Integrated wiper systems on the turbidimeters were successful at eliminating biofouling, while simple anti-biofouling techniques employed for the light transmissometer were only moderately successful. Elevated turbidity events measured at the buoy were diluted by at least a factor of three-to-one compared to in-creek turbidity. Overall, the Third Creek watershed exceeded current near-shore thresholds of 3 NTU during 4% of the 3451 hours that the buoy was deployed. Based on their poor performance at ultra-low turbidity levels, turbidimeters were found to be acceptable only at quantifying obvious clarity-degrading events such as for compliance monitoring. Alternative measurements such as light transmissivity were found to be better suited for long-term clarity measurements. Results were used to highlight deficiencies of current nearhsore water quality standards that should be addressed by basin managers when considering future threshold updates.

Differential Tolerances to UVR & Fluoranthene Exposure: Comparisons Between Native & Invasive Fish Species of Lake Tahoe (CA/NV)

A.K. Gevertz*
J.T. Oris
A.J. Tucker
C.E. Williamson

***Department of Zoology, Miami University, Oxford, Ohio 45056. akgevertz@gmail.com**

The purpose of this study was to determine how multiple stressors affect both invasive and native fish species in Lake Tahoe (CA/NV). The stressors included natural ultraviolet radiation (UVR) exposure and the exposure to a phototoxic polycyclic aromatic hydrocarbon (PAH), fluoranthene (FLU). Due to human development, both UVR attenuation and PAH levels are increasing, affecting natural processes of the lake. Responses to these stressors in the native Lahontan Redside minnow (*Richardsonius egregius*) and the invasive Bluegill sunfish (*Lepomis macrochirus*) were compared in controlled field studies. The objectives of the study were to understand the population effects of exposure to different levels of UVR and photo-activated FLU in the two fish species. Toxicity tests were conducted to determine the sensitivity/tolerance of each species. Damage to the epidermis and surrounding tissues were examined with transmission electron and light microscopy, serving as biomarkers of both exposure and effect. Natural defenses such as pigmentation and habitat choice were also investigated; clarifying in what ways both species may tolerate a range of exposure to UVR and FLU. Determination of the effects of these multiple stressors will help determine the invasive success of bluegill and similar species in Lake Tahoe and other oligotrophic, sub-alpine lakes that are susceptible to habitat alteration, nutrient inputs, and recreational activity.

Five Years of Vegetation Monitoring at Grass Lake Research Natural Area

Shana Gross*
Stuart Osbrack

***Lake Tahoe Basin Management, Unit 35, College Drive, South Lake Tahoe, California 96150.**
(530) 543-2752, segross@fs.fed.us

Funding source: Pacific Southwest Region, USDA Forest Service, Southern Nevada Public Land Management Act NEPA Resource Inventories, Surveys, and Analysis

Grass Lake was designated as a "Research Natural Area" by the Forest Service to preserve a representative Sphagnum bog type in the Northern Sierra Nevada physiographic province of Pacific Southwest Region. Grass Lake is the largest and best example of a Sphagnum "bog" (fen) in California. In addition, the Tahoe Regional Planning Agency has additional protection for Grass Lake under Vegetation Threshold V2 – Uncommon plant communities. Hydrologic change is predicted to be the largest threat to this community, which could be exaggerated by climate change.

Long term vegetation monitoring was initiated in 2004. Monitoring involves three components: 1) long term vegetation trend transect plots; 2) established photo points; 3) Sphagnum and Meesia triquetra cover distribution monitoring.

Preliminary analysis shows a 50% decline in area of Meesia and approximately a 20% decline in Sphagnum area, after five years. Further analysis will focus on community analysis.

This rapid decline in Sphagnum and Meesia triquetra, two fen indicator species, was unexpected. This decline may be linked to hydrologic changes.

Ski Slope Native Plant Revegetation Study

Shana Gross*, Lake Tahoe Basin Management

Jennifer Burt, University of California, Davis

Kathleen Nelson, Inyo National Forest

Susie Urie, Tahoe National Forest

Matt Brown, Eldorado National Forest

Deveree Kopp, San Bernardino National Forest

Elizabeth Bergstrom, Humboldt-Toiyabe National Forest

***Lake Tahoe Basin Management, Unit 35, College Drive, South Lake Tahoe, California 96150. (530) 543-2752, segross@fs.fed.us**

Funding source: Pacific Southwest Region, USDA Forest Service, Southern Nevada Public Land Management Act NEPA Resource Inventories, Surveys, and Analysis

Ski slopes represent large-scale disturbances in high elevation ecosystems, many of which are located on USDA Forest Service lands. Although USDA Forest Service policy mandates the use of native species where possible in revegetation, ski slopes are more often seeded with nonnative erosion control grasses. The goal of the project was to develop a native seed mix for each of the eight ski resorts that will perform as well or better at establishing vegetative cover and reducing erosion than the current erosion control mixes used at ski resorts.

A native seeding palette of 21 species was developed for ski slope revegetation, based on a reference site analysis of plant communities naturally occurring on ski slopes across the northern Sierra Nevada. Using extensive data on plant community composition of ski slopes from twelve abandoned and seven active ski areas, we identified native, herbaceous or low-growing (i.e. recreation compatible) plants that have naturally colonized ski slopes of this region. We pruned this large plant community dataset further to focus on plants that were found with high frequency and abundance across sites.

Here, we present the 21 plant species and the experimental design we are using to test establishment success of identified plant species on ski slopes across six National Forests, with the aim of improving ski slope revegetation practices.

The long-term goal of this study is to develop seed bulking sites on ski slopes to generate sources of native-adapted seed for local revegetation projects.

Mountain Pine Beetle (*Dendroctonus Ponderosae*) Dynamics at Three Elevation Zones in the Lake Tahoe Region

C.E. Jensen*
B.J. Bentz
P.E. Maloney
S.L. Smith
J.C. Vandygriff
D.R. Vogler

***Institute of Forest Genetics, USDA Forest Service, 2480 Carson Road, Placerville, California 95667-5107. (530) 400-3037, jensencamille@gmail.com**

Funding sources: Southern Nevada Public Lands Management Act, and USDA Forest Service Health Monitoring funds.

Mountain pine beetle (*Dendroctonus ponderosae*) is a primary mortality agent of pines in western North America and is a major threat to a number of Pinus species in California. Much of the research on mountain pine beetle has occurred in the Rocky Mountain States but little is known about its biology and behavior in montane coniferous forests of California.

Sugar pine (*Pinus lambertiana*), western white pine (*Pinus monticola*), and whitebark pine (*Pinus albicaulis*) populations are hosts to the mountain pine beetle and occur in three elevation zones (e.g., lower montane, upper montane and subalpine) within the Lake Tahoe Basin. In twenty-eight forest monitoring plots the percent incidence of mountain pine beetle in individual plots ranged from 0 to 28%. The mean incidence was highest in western white pine plots at 9.6%, while whitebark and sugar pine plots averaged 2 and 2.5% incidence, respectively. Flight period started in mid-June at 6,500 ft, and mid-July at 7,800 and 9,000 ft and was monitored at nine sites from May through September 2007.

In collaboration with the Rocky Mountain Research Station, we are completing the first year of preliminary research on mountain pine beetle biology and behavior within the Lake Tahoe region. Three locations with large beetle populations were selected to monitor the influence of microclimate and host species on beetle development and flight period. Further results will be discussed.

Explaining BMP Compliance Based on Private Landowner Characteristics

Derek Kauneckis*
Department of Political Science; University of Nevada, Reno

Michaela Flagg
Environmental & Resource Economics Department; University of Nevada, Reno

Jamie Bernthal
Political Science and Economics & Business Department, Cornell College

*** University of Nevada, Reno, Department of Political Science, Reno, Nevada 89557. kauneck@unr.edu**

Funding Source: The Academy for the Environment & College of Liberal Arts, University of Nevada, Reno.

The Lake Tahoe BMP retrofit program attempts to influence the behavior of private landowners to install a variety of erosion control measures. Convincing property owners to participate in the program requires understating the underlying motives of landowners, their incentives, perceptions of the program and barriers to increased participation. Using results from a survey of approximately 500 landowners this study examines the effect of environmental attitudes, socio-demographic characteristics, perceptions of the efficacy of current policies, and the costs of implementation. The results indicate that landowner characteristics, having had a face-to-face meeting with a TRPA official, and identifying as being moderately active in the community are statistically significant indicators of participation. Implications for increasing participation in the BMP retrofit program are discussed.

The Effects of Climate Change on Alpine Bumble Bee Community Structure

Gretchen LeBuhn*
Brendan Colloran

***Biology, San Francisco State University, 1600 Holloway Avenue, San Francisco, California 94132.**
(415) 338-1111, lebuhn@sfsu.edu

Previous research on a pollinator community comprised of 14 species of bumble bees in the northern Sierra Nevada of California showed that there is dramatic variation in the species found in any given meadow from one year to the next and across meadows within a year. For example, many meadows had an over 50% change in bumble bee species composition from 2002 to 2003 and again from 2003 to 2004. Not only does the species composition change, the total number of species found in a meadow can vary dramatically. To understand the dynamics of this system, we developed a model to examine how year to year variation in snowmelt and interspecific competition influence bumble bee communities at different elevations.

Our model suggests small changes in the timing of snowmelt can influence the number of species in a meadow and year to year turnover. When combined with predictions about global climate change, this model suggests there will be substantial changes in our alpine pollinator communities. In addition, we demonstrate that restoration of meadow hydrology can have significant positive effects on maintaining bee diversity under climate change.

Effects of Prescribed Fire & Season of Burn on Direct & Indirect Levels of Tree Mortality in Eastside Pine Forest of the Sierra Nevada

Stephen R. McKelvey*
Christopher J. Fettig
Sierra Nevada Research Center, Pacific Southwest Research Station

Daniel R. Cluck
Shari L. Smith
Forest Health Protection

***USDA Forest Service, 2480 Carson Road, Placerville, California 95667-5107**

This research was supported, in part, by a Special Technology & Development Program grant to C.J.F., S.L.S., D.L.C. and W. Otrosina (Southern Research Station), a US President's Early Career Award for Scientists & Engineers to C.J.F., the Pacific Southwest Research Station and Forest Health Protection.

Many forests in the Lake Tahoe basin that historically experienced frequent low-intensity wildfires have undergone extensive alterations during the past century due to logging and fire suppression. Prescribed fire is now commonly used to restore these fire-adapted forest ecosystems. In this study, we examined the influence of prescribed burn season on levels of tree mortality attributed to prescribed fire effects (direct mortality) and bark beetles (*Colepoptera: Curculionidae, Scolytinae*) (indirect mortality) in Jeffrey pine, *Pinus jeffreyi* Grev. & Balf., and ponderosa pine, *P. ponderosa* Dougl. ex Laws., forests. Nine 4 ha plots were established near Truckee, CA. in 2005 on the Tahoe National Forest and randomly assigned treatments (n=3): 1) spring prescribed burn, 2) fall prescribed burn, 3) and untreated control. Significantly higher levels of tree mortality (all sources) occurred following early and late season burns compared to the untreated control, but no significant difference was observed between burn treatments. The majority (461) of tree deaths was attributed to direct mortality from the prescribed burns and was strongly aggregated (391) in the smallest diameter class (<20.2 cm diameter at breast height). For the largest trees (>50.7 cm dbh), significantly higher levels of tree mortality occurred on early season burns (15) than the untreated controls (0), most of which resulted from indirect mortality attributed to bark beetles, specifically western pine beetle, *Dendroctonus brevicomis* LeConte, mountain pine beetle, *D. ponderosae* Hopkins, and the Jeffrey pine beetle, *D. jeffreyi* Hopkins. Mortality occurred on only 2 large diameter trees (>50.7 cm dbh) in the late season burns, but this was not significantly different from large tree mortality on the early season burns due to the fact that there were more large trees on the landscape in the early season burn plots. The goal of most ecosystem restoration projects in the Lake Tahoe basin is to reduce fuel loads and the risk of catastrophic wildfire while at the same time retain most if not all of the larger trees on the landscape. The results of this study suggest that late season burns are more likely to meet ecosystem restoration goals in the Lake Tahoe basin than early season burns.

A Unique Place:
The Institute of Forest Genetics Research Greenhouse

Annette Delfino Mix*
Detlev Vogler

***Pacific Southwest Research Station, Institute of Forest Genetics, USDA Forest Service, 2480 Carson Road, Placerville, California 95667-5107. (530)-295-3023, amix@fs.fed.us**

Funding from the Southern Nevada Public Lands Management Act, and from the Forest Service, North and Central zone tree improvement, Region Five, State & Private Forestry, Special Technology Development Program (2005-2009), and the Aspen Delineation Project (FS, BLM, and CA DF&G), has supported this research.

The Institute has been actively engaged in research on white pine blister rust since 1968. In the greenhouse the major gene resistant screening for sugar pine and western white pine was developed. The protocols are now used by the Region 5 nursery at a production level. Blister rust research done today at the Institute's greenhouse by the experienced staff has moved up the hill into the high elevation white pine species: Rocky Mtn. Bristlecone, Great Basin bristlecone, limber, whitebark, and foxtail pine. This has been made possible using the years of observing and recording the host response phenotypes on sugar pine and western white pine to interpret the more complicated reactions to the disease of these high elevation species.

White pine blister rust research is only one of the focuses at the Institute of Forest Genetics greenhouse. Over the past decade the greenhouse has been renovated to be able to carry out most research goals, from vegetative propagation of Port-Orford cedar and aspen to growing native grasses.

Without this unique greenhouse at the Institute of Forest Genetics and support to maintain a research greenhouse-experienced staff, the research on these types of forest and range restoration projects would be limited.

Meadow Ecosystem Response to Restoration of the Stream Channel/Meadow Surface Relationship at Cookhouse Meadow

Craig Oehrli

USDA Forest Service, Lake Tahoe Basin Management Unit, 35 College Blvd., South Lake Tahoe, California 96150. (530) 543-2681, coehrli@fs.fed.us

Funding Source: Southern Nevada Public Lands Management Act (SNPLMA) & LTRA (US Congress)

A dysfunctional relationship between stream channel and meadow surfaces is a common problem on meadows in the Tahoe Basin. A poor water connection between the stream and meadow surface can adversely affect seasonal ground water levels, stream function, and vegetation communities on stream banks and adjacent meadow surfaces. Cookhouse Meadow, located in the Big Meadow Creek a tributary stream to the Upper Truckee River, was an example of a dysfunctional stream-meadow surface relationship. A combination of land use impacts and floods triggered channel incision and the creek flowing through Cookhouse cut down 2 to 13 feet below its presumed pre incision level. A project to restore the stream channel / meadow surface relationship began in 2005 and was completed in 2006. The project involved the construction of 2400 feet of new stream channel followed by the plug and partial fill of the historic gully. Monitoring over the three following seasons documented a recovery of functional ground water patterns, the recovery of meadow surface flooding frequency, desired stream channel cross section and longitudinal profile dynamics, and meadow vegetation vigor. Pre and Post construction wildlife surveys detected that a sensitive species (yellow warbler) began occupying the site after restoration was complete. Future seasonal snow accumulation that is above average (snow accumulation of greater than 100% of average) will trigger additional monitoring in the future.

Lake Tahoe Stormwater Basins: Botanical Surveys, Comparisons & a Greenhouse Trial

David Rios*
Sudeep Chandra
Alan Heyvaert
Desert Research Institute

***Department of Natural Resources & Environmental Science, University of Nevada, Reno, 1000 Valley Road/MS 186, Reno, Nevada 89512. (775) 784-6646, divadrois@gmail.com**

Stormwater treatment in Lake Tahoe is a primary concern for land managers. Vegetated stormwater basins are a common tool for capturing and treating stormwater through biological and physical processes. Native vegetation establishment at these sites is often a project goal. However, the practices associated with establishing native vegetation in stormwater basins are not standardized and measuring the success for these projects is often overlooked.

This research established baseline plant community composition for 16 stormwater basins in Lake Tahoe. Site comparisons were made with past survey data to understand changes over time. Establishment success within basin floor and upland communities was explored to understand the efficacy of our revegetation practices. Finally, we examined soil inoculation, a common revegetation practice, and its effects on native plant establishment.

The majority of species detected within constructed stormwater basins were native, while a small percentage was identified as introduced. Dry upland plant communities had a larger percentage of introduced species compared with the moist basin floor communities. Species richness and the number of introduced species declined over time. Greenhouse trials indicate inoculating soil with a root fungus does not achieve improved plant performance.

Constructed stormwater basin plant communities do not represent invasion hot spots. Spot treatment for introduced species should focus on the dry, disturbed, upland communities surrounding these basins. We recommend further field testing to understand the influence root fungi may have on improving plant performance.

Effects of Harvesting System & Prescribed Fire on Natural Regeneration in a Jeffrey Pine Stand: Implications for Lake Tahoe Basin Forests

Wade G. Salverson*
Roger F. Walker
Robert M. Fecko
Wesley B. Frederick
Watkins W. Miller
Dale W. Johnson

***Department of Natural Resources & Environmental Science, University of Nevada,1000 Valley Road, Reno, Nevada 89512. (530) 249-0243, wsalverson@hotmail.com**

Funding Source: Nevada Agricultural Experiment Station, McIntire-Stennis Cooperative Forestry Research Program, USDA/USDI Joint Fire Sciences Program.

Thinnings using cut-to-length and whole-tree harvesting systems with subsequent prescribed underburning were assessed for their effects on seedling and sapling demography in a pure, uneven-aged Jeffrey pine (*Pinus jeffreyi*) stand containing a small number of California white fir (*Abies concolor var. lowiana*). Depression of seedling counts by forest floor disturbance associated with the thinning operations was followed by a recovery largely confined to Jeffrey pine regeneration in the whole-tree treatment where final seedling counts exceeded those found initially. The postburn substrate was more favorable for the establishment of Jeffrey pine than white fir seedlings, and the largest increase overall in seedling counts between the initial and final inventories occurred in the burned portion of the whole-tree treatment. Live sapling losses from thinning were greatest in the cut-to-length treatment, while underburning induced complete mortality within this size class. Absent treatment, a variety of stand and site variables were found to influence seedling and sapling abundance, prominent among them a propensity for mahala mat (*Ceanothus prostratus*) to elevate counts of white fir within both size classes. Because Jeffrey pine stands are prevalent in the Lake Tahoe Basin and surrounding area, results of this study can be readily extrapolated to similar stands, thus facilitating predictions of the forest structure modifications produced by management practices that are being increasingly utilized in ecological restoration efforts.

Seismic & Volcanic Hazards at Lake Tahoe

Ken Smith*
Graham Kent

***Nevada Seismological Laboratory, University of Nevada Reno; M/S 174, Reno, Nevada 89557.**
(775) 784-4218, ken@seismo.unr.edu

Funding source: State of Nevada and the US Geological Survey

Persistent seismicity, active Holocene faults, and recent seismic and geodetic evidence for lower-crustal volcanism, underscore the need for comprehensive monitoring of Tahoe's active tectonic processes in support of effective outreach/education, preparedness, response planning, and modern geologic hazard studies. UNR Seismology operates a limited, mostly analog, real-time seismic network in the Tahoe Basin. Historical earthquake activity is primarily focused north of Lake Tahoe in a northeast trending zone of seismicity that extends from north of Tahoe City, through the Mt. Rose area, and into the western Truckee Meadows. The primary east dipping basin normal faults are generally free of micro-earthquake activity, yet pose the greatest threat to basin communities. The North Tahoe area has experienced several magnitude 4+ earthquakes since 1998 (1998: Magnitude 4.9, 2004: Magnitude 4.5, 2005: Magnitude 4.8). Larger events (M ~6) in North Tahoe would not be unexpected. What role these persistent zones of seismicity play in the inter-seismic period of large basin area normal faulting earthquakes is poorly understood. Seismic and geodetic evidence for an ~0.04 km^3 lower-crustal magma injection event in 2003 illustrates the complex nature of the active tectonics of the Lake Basin region. Modernizing earthquake monitoring systems (including notification processes) and additional geodetic monitoring stations would significantly improve our ability to isolate active structures, understand the deformation of the basin, and identify seismic and aseismic processes associated with potential volcanism, for the public, emergency managers, and regional planners.

The Impact of Asian Dust Aerosols on Lake Tahoe

Jason Snyder*
Thomas A Cahill
Charles Goldman
David Barnes

***DELTA Group, University of California, Davis, One Shields Avenue, 105 Walker Hall, Davis, California 95616. (530) 752-1120, jmssnyder@ucdavis.edu**

Funding source: US Environmental Protection Agency

Recent modeling of water clarity at Lake Tahoe has highlighted the importance of insoluble fine particles being deposited from the atmosphere. While there are many sources of such particles including construction and winter road salting, etc., numerous studies have shown that Asian dust has also impacted air quality and visibility from Northern California to Washington. The focus of this study was to see if such dust was a significant factor in lake clarity in terms of particle loading and nutrient loading associated with such particles. Based on rotating DRUM sample records, at the Tahoe Fish Hatchery (Courtesy of the UC Davis DELTA Group), the period from April 27 to June 2 2006 saw an increase in soil aerosol deposition into Lake Tahoe. Often the particle size of these aerosols was from 0.75 μm to 2.5 μm in diameter (particle size stages 3-4 based on the drum sample notation), too fine to be local soil. Low iron to calcium ratios and HYSPLIT trajectories associated this increased soil deposition identified Asian dust from primarily around the Gobi desert region. Increased Asian dust deposition was associated with there being increased MJO convection in the Central to Eastern Pacific Ocean. Such convection is associated with increased westerly winds in the mid latitude Pacific, which is known to be conducive to Asian dust transport. Associated with this soil deposition was also increased deposition in sulfur aerosols which further confirms the Asian origin of such the soil aerosols.

Impact of Terrestrial Sediment Sources on Nearshore Water Quality

Richard B. Susfalk*
Alan Heyvaert
Brian Fitzgerald

***Division of Hydrologic Sciences, Desert Research Institute, 2215 Raggio Parkway, Reno, Nevada 89512. (775) 673-7453, Rick.susfalk@dri.edu**

Funding Sources: Southern Nevada Public Lands Management Act, Nevada Division of State Lands Lake Tahoe License Plate Program

Maintaining the aesthetic and environmental quality of Lake Tahoe's nearshore zone is important as it supports aquatic species and is the area where most residents and visitors interact with the lake through activities such as swimming, kayaking, or enjoying its clear waters from shore. Although challenges to the quality of the nearshore have increased over time, little information exists that directly links terrestrial sediment sources with degraded nearshore water quality.

Several storm water and stream outfall points in the City of South Lake Tahoe were monitored during selected events between the fall of 2008 and the summer of 2009. The load of suspended sediment entering the lake was estimated using continuous turbidity measurements as a surrogate, with discrete samples analyzed for particle size distribution. Maps delineating the extent and magnitude of resulting nearshore water quality were constructed utilizing surveys conducted by jet boat. Parameters that were measured included turbidity, light transmissivity, chlorophyll fluorescence and water temperature. Continuous in-situ measurements of turbidity and water temperature taken from a manually powered canoe were needed to augment this dataset due to the extremely low lake levels.

The focus of this study was to develop the linkages between terrestrial sediment sources and their ability to affect nearshore water clarity in response to characteristic hydrologic events. Results from this study will benefit basin managers seeking to revise nearshore indicators and standards by quantifying current conditions, locating potential problem areas, and indentifying deficiencies in current standards.

Water Temperature & Ultraviolet Radiation Transparency Interact to Control Invasive Warm-Water Fish Establishment in Nearshore Lake Tahoe

Andrew Tucker*
Craig Williamson
James Oris
Amanda Gevertz
Miami University

Mark Olson
Franklin & Marshall College

***Department of Zoology, Oxford, Ohio 45056. (513) 529-3191, tuckera2@muohio.edu**

Funding sources: 1) Southern Nevada Public Lands Management Act grant awarded to University NV-Reno (Sudeep Chandra PI, J. Oris, C. Williamson, and G. Schladow Co- PIs) for "NICHES: Nearshore Indicators for Clarity, Habitat and Ecological Sustainability." 2) Miami University Field Workshop funds.

The increasing incidence of non-native plant, vertebrate, and invertebrate species is transforming the nearshore environment of Lake Tahoe. In response, management agencies have called for research to assess the habitat suitability of Lake Tahoe to support the establishment of priority invasive species. We examined how water temperature and transparency to ultraviolet radiation (UVR) influence the suitability of nearshore habitats in Lake Tahoe for invasive warm-water fish. UVR transparency and water temperature were measured at ten nearshore sites from May to October 2009. In a controlled experiment we exposed larval bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) to solar UVR to establish a UVR dose-response relationship for each species. Results from the dose-response experiment were combined with UVR transparency data from monthly profiles to predict fish survival in each nearshore site as a function of UVR exposure. We used data from the literature concerning the effect of temperature on survival of early life history stages to predict larval fish survival at each nearshore site as a function of temperature. UVR and temperature dependent survival estimates were combined to produce a single estimate of survival at each nearshore site. Our results suggest that current UVR transparency and water temperature limit establishment of non-native fish in most, though not all, nearshore sites. However, continued threats to nearshore water clarity (i.e. UVR transparency) and ever increasing nearshore water temperature are likely to make Lake Tahoe more suitable for warm-water fish invasion in the future.

Fire History of Coniferous Riparian Forests in the Lake Tahoe Basin

Kip Van de Water

USFS Sierra Nevada Research Center, Malcolm North, University of California, Davis, 9516 Azalea Drive, Etna, California 96027.Angry_hour@yahoo.com

Funded by the Southern Nevada Public Land Management Act

Fire is an important ecological process in many western U.S. coniferous forests, yet high fuel loads and rural home construction lead to the suppression of most wildfires. Using mechanical thinning and prescribed burning, managers often try to reduce fuels in strategic areas with the highest fuel loads. Riparian forests, however, are often designated as areas where limited management action can take place within a fixed-width zone. These highly productive zones have developed heavy fuel loads capable of supporting stand-replacing crown fires that erode stream channels, eliminate important wildlife habitat and degrade ecosystem function. Objectives of this study are to determine whether adjacent coniferous riparian and upland forests burned historically with different frequencies and seasonalities, whether they had different stand structures and fuel loadings, and whether the relationship varied by forest type, riparian zone widths, and precipitation regimes. We measured dendrochronological fire records, current stand structures, and fuel loadings in adjacent riparian and upland sites in three forest types (mixed-conifer, white fir, Jeffrey pine), two riparian zone widths (broad and narrow), and two precipitation regimes (dry east side and wet west side). There was significant variation between fire regimes in different forest types, riparian zone widths, and precipitation regimes. Preliminary results indicate that adjacent riparian and upland forests did not differ significantly with respect to historic fire frequency and seasonality. Current forest practices which generally do not treat riparian areas leave these zones at risk of burning with uncharacteristic severity due to their high stem density and fuel loading.

Effects of Harvesting System & Prescribed Fire on Forest Floor Vegetation in a Jeffrey Pine Stand: Implications for Lake Tahoe Basin Forests

Roger F. Walker*
Wade G. Salverson
Robert M. Fecko
Wesley B. Frederick
Dale W. Johnson
Watkins W. Miller

***Department of Natural Resources & Environmental Science, University of Nevada, Reno, 1000 Valley Road, Reno, Nevada 89512. (775) 784-4039, walker@cabnr.unr.edu**

Funding Source: Nevada Agricultural Experiment Station, McIntire-Stennis Cooperative Forestry Research Program, USDA/USDI Joint Fire Sciences Program

Thinnings using cut-to-length and whole-tree harvesting systems followed by prescribed underburning were assessed for their effects on shrub, forb, and grass understory species in a second-growth Jeffrey pine (*Pinus jeffreyi*) stand on the Tahoe National Forest. Prior to treatment installation, a mixed shrub-dominated understory featuring antelope bitterbrush (*Purshia tridentata*) with mules ears (*Wyethia mollis*) as the only forb and Sandberg's bluegrass (*Poa sandbergii*) the most prominent among sparse grasses was inventoried such that both percent cover and dry weight by species was revealed. Five growing seasons after thinning and four after underburning, this inventory was repeated. By either abundance measure, bitterbrush was reduced by approximately two-thirds in the cut-to-length treatment and by one-half in the whole-tree treatment in comparison to that in the unthinned control at the final inventory. For the cut-to-length treatment, a similar reduction in mules ears was noted, but that in the whole-tree treatment was somewhat less for this species. Bluegrass was reduced by approximately one-half in the former treatment and by three-fourths in the latter. Prescription fire reduced bitterbrush to less than one-tenth and mules ears to approximately one-half of that in the unburned treatment, but bluegrass prevalence was more than 10X greater in the burned than in the unburned treatment. Among an array of regression models used to evaluate selected variables for their predictive capacity regarding understory plants, posttreatment prevalence in burned plots of each of the three species noted above was positively correlated with their prevalence prior to burning. Because Jeffrey pine stands are prevalent in the Lake Tahoe Basin and surrounding area, results of this study can be readily extrapolated to similar stands, thus facilitating predictions of the understory modifications produced by management practices that are being increasingly utilized to restore wildlife habitat and fire resilience in the Lake Tahoe Basin and eastern Sierra Nevada.

Asian Clam (*Corbicula Fluminea*) Filtration & Excretion Rates: Impacts to Nutrient Cycling & Primary Productivity in Lake Tahoe

Marion Wittmann, Ph.D.*
Sudeep Chandra, Ph.D.
University of Nevada, Reno

John Gardner
University of Missouri, Columbia

***UC Davis Tahoe Environmental Research Center, 291 Country Club Drive, Incline Village, Nevada 89451. (775) 881-7560 x 7402, mwittmann@ucdavis.edu**

Funding source: National Science Foundation Research Education for Undergraduate to the University of Nevada- Reno, Southern Nevada Public Lands Management Act from the Pacific Southwest Research Station, Nevada Division of State Lands License Plate Fund

The invasive bivalve Asian clam (*Corbicula fluminea*) is observed in high densities in Lake Tahoe (>4000 individuals/m^2) and can impact ecosystem processes such as nutrient cycling and primary production through filter feeding and excretion. In other systems Asian clam filtration, and elevated metabolic and excretion rates have resulted in elevated levels of nitrogen and phosphorus release and subsequent increases in algal biomass. In 2008 and 2009 filamentous algal blooms were observed in conjunction with high density Asian clam beds.

A laboratory experiment measured the amount of ammonium and soluble reactive phosphorus excreted by various size classes of Asian clam over a 12 hour period. A feeding experiment measured filtration rates for two clam size classes using Tahoe water. Algal concentrations (and thus, uptake rates) were measured over 48 hours using fluorometry.
Asian clam excrete elevated levels of ammonium and phosphorus in relation to background concentrations in Lake Tahoe. The amount of nutrients excreted varied by clam size and temperature. Asian clam filtration rate is 0.39 L/hr for large clams (mean =17.94 mm) and 0.29 L/hr for small clams (mean = 10.6 mm).

Asian clams are impacting nutrient cycling in Lake Tahoe as a result of high rates of water filtration and nitrogen and phosphorus excretion. The presence of associated filamentous algae is an indication of this impact. Further studies on relative filtration rates of macroinvertebrates are needed to understand these impacts on the greater benthic community.