Lake Mead Science Symposium

January 13 and 14, 2009
Las Vegas, Nevada

PROGRAM
UNLV Student Union • Second Floor Floorplan
Symposium locations are indicated in blue

Need Assistance? Call 702-324-3105
Welcome

Lake Mead is the largest reservoir by volume in the United States, providing diverse recreational opportunities, habitat for numerous fish and wildlife species, drinking water for millions of people, hydropower generation, and water for agricultural uses. The challenges and issues associated with the drought and the introduction of invasive species are of great concern. This symposium was designed for participants to share information important to the development of an interagency ecological monitoring plan for Lakes Mead and Mohave. The symposium features three important plenary talks and six concurrent sessions: Emerging Issues, Limnology and Water Quality, Riparian and Shoreline Resources, Aquatic Biota and Fisheries, Environmental Contaminants, and Lake Management. An overarching goal of these sessions is to identify data gaps, increase coordination of the various efforts, and provide a foundation for future research endeavors. We appreciate your time and commitment in attending the Lake Mead Science Symposium.

2009 Lake Mead Science Symposium Committee

Conference Program Chair:
Kent Turner  
National Park Service  
Lake Mead National Recreation Area

Event Coordinator:
Rochelle Boyd  
Public Lands Institute  
University of Nevada Las Vegas

Planning Chairs:
Jennell M. Miller, Ph.D.  
Public Lands Institute  
University of Nevada, Las Vegas
Margaret N. “Peg” Rees, Ph.D.  
Public Lands Institute  
University of Nevada, Las Vegas
Craig J. Palmer, Ph.D.  
Harry Reid Center For Environmental Studies  
University of Nevada, Las Vegas

Technical Committee:
Scott Abella, University of Nevada, Las Vegas • Shawn Gerstenberger, University of Nevada, Las Vegas • Steven L. Goodbred, U.S. Geological Survey • Chris Holdren, U.S. Bureau of Reclamation • Jef R. Jaeger, University of Nevada, Las Vegas • Michael S. Lico, U.S. Geological Survey • Erik Orsak, U.S. Fish and Wildlife Service • Jon Sjöberg, Nevada Department of Wildlife • Peggy Roefer, Southern Nevada Water Authority • Michael R. Rosen, U.S. Geological Survey • Todd E. Tietjen, Southern Nevada Water Authority • Cris Tomlinson, Nevada Department of Wildlife • Kent Turner, National Park Service, Lake Mead National Recreation Area

CONTENTS
Welcome  
1
Plenary Session  
2
Sessions at a glance  
5
Abstracts  
7
Exhibitors  
8
Author Directory  
23
TUESDAY MORNING • January 13, 2009

9:00 am  Welcome to the University of Nevada, Las Vegas
          Ronald Smith, Ph.D., Vice President for Research and Graduate Studies and Dean of the Graduate College

9:05 am  Opening Remarks
          Kent Turner, Chief of Resource Management, National Park Service, Lake Mead NRA

9:15 am  Special Remarks
          Tom Porta, P.E., Deputy Administrator, Nevada Division of Environmental Protection
          Kimball E. Goddard, Director, U.S. Geological Survey, Nevada Water Science Center
          Lorri Gray, Regional Director, U.S. Bureau of Reclamation, Lower Colorado Region

9:35 am  Keynote Address: "Value of Lake Mead"
          Alan O'Neill, Executive Director, Outside Las Vegas Foundation

10:05 am Jim LaBounty Memorial

10:15 am Break

10:35 am Keynote Address: "Limnological and Hydrological Overview of Lake Mead"
          G. Chris Holdren, Ph.D., U.S. Bureau of Reclamation, Denver Office

11:10 am Keynote Address: "Lake Mead: Water Uses, Demands, and Changes in Lake Levels"
          Terrance J. Fulp, Ph.D., Deputy Regional Director, U.S. Bureau of Reclamation, Lower Colorado Region

MEALS

Continental breakfast featuring fresh fruit, yogurt, boiled eggs, pastries, etc. will be served both days in the area adjacent to the ballroom beginning at 7:30 am.

Lunch will be served both days beginning at 11:45 am in the Hazel M. Wilson Dining Commons located west of Tonopah Hall and south of the Central Desert Complex (see campus map on the inside back cover of this program). The all-you-can eat buffet includes a soup and salad bar, pizzarette, grill, made-to-order international station, American-fare classics station, and dessert bar. Each registrant receives two lunch coupons (located in your conference badge holder).

Please join us at the cocktail and hors d’oeuvre reception on Tuesday evening (5:00 pm - 6:00 pm) during the poster reception. Located in your conference badge is a coupon for a complimentary beverage.

IN MEMORIAM – JAMES F. LABOUNTY, PHD 1942 - 2008

James (Jim) LaBounty was an aquatic scientist who spent the last 19 years working on the ecology and limnology of Lake Mead with an emphasis on Boulder Basin. He received a B.S. and M.S. in Biology from the University of Nevada, Las Vegas and a Ph.D. in Zoology from Arizona State University. LaBounty retired in 2000 from the U.S. Bureau of Reclamation (USBR) after 30 years of service. He was Head of the Environmental Research Program for the Bureau of Reclamation. He has been an aquatic scientist consultant with the Southern Nevada Water Authority since February 2000. Throughout his career he continued active research investigating the limnology of lakes and reservoirs throughout the western United States. His 14 years of cooperative research with colleagues from Spain produced numerous publications describing various limnological features of reservoirs in Spain. He also worked in China, Honduras, Guyana, Japan, and New Zealand. LaBounty was Editor of the international journal Lake and Reservoir Management for the past 12 years. He published extensively on the limnology of Boulder Basin. His most recent publication, (Secchi transparency of Boulder Basin, Lake Mead, Arizona-Nevada: 1990–2007, Lake and Reservoir Management, September, 2008, Volume 24, Number 3, pages 207-218), documents over 17 years of water clarity data from Boulder Basin that includes over 5,500 data points. The paper relates water clarity to chlorophyll and nutrient concentration. The results described in this publication form an important baseline of information prior to establishment of the introduced quagga mussel.
**ALAN O’NEILL**

Alan O'Neill has served as Executive Director of the Outside Las Vegas Foundation since its formation in October 2000. The Foundation is a private nonprofit organization that was established at the request of the four federal land management agencies in Southern Nevada to enhance community involvement, build partnerships, and help promote private philanthropy in support of conservation initiatives on the federal lands and within the local jurisdictions. Prior to leading the Foundation, O’Neill worked for the U.S. Department of the Interior for 34 years, most of which was with the National Park Service. He served as Superintendent of the Lake Mead National Recreation Area from August 1987 until September 2000. O’Neill is the recipient of numerous awards from federal, state, and local governments and nonprofit organizations for innovative program development and leadership and as a tireless advocate for conservation and sound stewardship. He is a recipient of the Department of the Interior’s acclaimed Meritorious Service Award for his career achievements and the National Park Service Director’s Award as Superintendent of the Year for Resource Stewardship. O’Neill also received Vice President Al Gore’s Hammer Award for reinventing government in his role implementing the California Desert Protection Act. In April 2001, he received the Nevada Conservationist of the Year Award from the National Wildlife Federation. The Outside Las Vegas Foundation was the 2006 recipient of the prestigious Kodak American Greenways Award given annually by the Eastman Kodak Company, National Geographic Society and The Conservation Fund for its leadership in developing and implementing a Regional System of Trails and Open Space in Southern Nevada.

In recognition of the relationship between access to natural open spaces and quality of life, O’Neill works to help Southern Nevadans discover a sense of place outside Las Vegas. It is his belief that imparting lasting connections between people and their public lands will both improve quality of life for citizens and inspire them to care about their natural and cultural heritage—and ultimately participate in the stewardship of their surrounding natural areas. O’Neill has Bachelor’s and Master’s degrees in Geography from the University of Maryland and is a native of Washington, D.C.

"The Value of Lake Mead"

**G. CHRIS HOLDREN, PHD**

Chris Holdren is the Manager of the Environmental Applications and Research Group at the U.S. Bureau of Reclamation in Denver, Colorado. His responsibilities include a variety of water projects throughout the western United States, including continuing studies of Lake Mead, Arizona-Nevada, and the Salton Sea, California. Dr. Holdren has 30 years of experience with lake and watershed management programs, with particular expertise in water and sediment chemistry and lake eutrophication.

"Limnological and Hydrological Overview of Lake Mead"
The impact of the current drought, the worst in approximately 100 years of record-keeping, is clear. On October 1, 1999, Lake Powell and Lake Mead were together over 95% full (with approximately 47.6 million acre-feet of water in storage) and on October 1, 2008, those reservoirs were 53% full (approximately 26.5 million acre-feet of water in storage). Also clear is the value of the storage capacity on the Colorado River system, which allows for the storage of water during the high flow years and the subsequent use of that water, particularly during low flow years. More than 80% of the 60 million acre-feet of storage capacity on the Colorado River system is contained in Lake Powell and Lake Mead.

In response to the lingering drought and the lack of specific operational guidelines for the coordinated operation of Lake Powell and Lake Mead, particularly for drought and low reservoir conditions, the Secretary adopted new guidelines in December 2007 that will be used for an interim period through 2026. These guidelines were the result of an intense, three-year effort by the U.S. Bureau of Reclamation, other federal agencies, and literally hundreds of stakeholders throughout the Basin in accordance with the National Environmental Policy Act of 1969 (NEPA).

Given continued and increasing demands for water Basin-wide, the high degree of hydrologic variability in the Basin, and the potential impacts of climate change, the future states of Lake Powell and Lake Mead are likely to look different than those seen in the past.

TERRANCE FULP, PHD

Terrance (Terry) Fulp, Ph.D., was appointed Deputy Regional Director of the Bureau of Reclamation’s Lower Colorado Region in March 2008.

Headquartered in Boulder City, Nevada, the Lower Colorado Region is responsible for the operation of the Reclamation’s water and power facilities on the last 688 miles of the Colorado River, from Lee’s Ferry in northern Arizona to the Mexican border. Fulp, a Reclamation employee since 1989, oversees programs that implement the Secretary of the Interior’s water master functions on the lower Colorado River, including water delivery, accounting, and contracting. Fulp is also responsible for the Region’s water conservation program and the Lower Colorado River Multi-Species Conservation Program, a multi-agency effort to conserve and work towards the recovery of endangered species and protect and maintain wildlife habitat on the lower Colorado River.

Fulp is actively involved in Colorado River operations and management issues, working closely with other federal and state agencies and various stakeholders on issues related to management and use of the river. Prior to his appointment as Deputy Regional Director, he served as Area Manager of the Boulder Canyon Operations Office where he managed and administered the successful Basin-wide effort to develop additional operational guidelines for Lake Powell and Lake Mead, thereby minimizing the effects of long-term drought in the Southwest.

Fulp was the principal investigator for the Department of the Interior’s Watershed and River Systems Management Program, a program to develop decision support tools for watershed management. With the cooperation of the Tennessee Valley Authority, the effort resulted in the development of RiverWare™, a sophisticated modeling framework now used by several water management agencies – including Reclamation, the Tennessee Valley Authority, and the Corps of Engineers – to plan and schedule the operations of river basin facilities to meet multiple objectives.

Fulp holds a Ph.D. in Mathematical and Computer Sciences from the Colorado School of Mines, a M.S. in Civil Engineering from the University of Colorado, a M.S. in Geophysics from Stanford University, and a B.S. in Earth Sciences from the University of Tulsa.

Fulp received the Superior Service Award, one of the Department of the Interior’s highest for career employees, and the Virgil M. Kauffman Gold Medal in from the Society of Exploration Geophysicists for his outstanding contribution to the advancement of geophysical exploration.
### TUESDAY AFTERNOON SESSIONS • January 13, 2009

**BALLROOM**

<table>
<thead>
<tr>
<th>Time</th>
<th>Emerging Issues</th>
<th>Limnology and Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:15 - 1:20 pm</td>
<td>SESSION OPENING</td>
<td>SESSION OPENING</td>
</tr>
<tr>
<td>1:20 - 1:45 pm</td>
<td>Quagga Mussel Invasion into Lakes Mead and Mohave in 2007: Abundance, Distribution, and Size Frequency (Moore, B. et al.)</td>
<td>What Are We Discharging? (Schiefer, S.)</td>
</tr>
<tr>
<td>1:45 - 2:10 pm</td>
<td>Growth and Recruitment of Quagga Mussels (<em>Dreissena bugensis</em>) in Lake Mead (Baldwin, W. et al.)</td>
<td>The U.S. Geological Survey’s Lake Mead Monitoring Network (Veley, R. et al.)</td>
</tr>
<tr>
<td>2:10 - 2:35 pm</td>
<td>Development of a Suitable Substrate Sampling Device for Monitoring Quagga Mussels (<em>Dreissena bugensis</em>) in Lake Mead, Nevada (Mueting, S. et al.)</td>
<td>Evaluation of Water Quality Monitoring Instruments with Cooperator Interagency Sampling Events in Lake Mead (Turkett, W.)</td>
</tr>
<tr>
<td>2:35 - 3:00 pm</td>
<td>Characterization of the Phytoplankton Communities in the Basins of Lake Mead – Do Quagga Mussels Influence Cyanobacterial Biovolume? (Beaver, J. et al.)</td>
<td>Long Term Patterns in the Diversity and Composition of Phytoplankton in Las Vegas Bay, Lake Mead (Tietjen, T.)</td>
</tr>
<tr>
<td>3:00 - 3:15 pm</td>
<td>BREAK</td>
<td>BREAK</td>
</tr>
<tr>
<td>4:05 - 4:30 pm</td>
<td>Will Quagga Mussels Potentially Impact the Native Species’ Food Web in Lake Mead by Affecting Plankton and Nutrient Availability? (Link, C. et al.)</td>
<td>SCOP Marine Investigations Field Program (MacKinnon, A. et al.)</td>
</tr>
<tr>
<td>4:30 - 4:55 pm</td>
<td>Lake Mead Zoobenthos: Changes in Composition, Distribution, and Composition over Time with Emphasis on the Ecology of Adult Quagga Mussel (Chandra, S. et al.)</td>
<td>EQuIS 5 LakeWatch: The Latest Advances in Lake Data Analysis Software (Weaver, S. and Beard, M.)</td>
</tr>
<tr>
<td>5:00 - 6:00 pm</td>
<td>Cocktail and Hors d’oeuvre Reception, Forever Earth Presentation, and Poster / Exhibit Session (Ballroom)</td>
<td></td>
</tr>
</tbody>
</table>

### POSTER SESSIONS • January 13 and 14, 2009

**BALLROOM**

<table>
<thead>
<tr>
<th>Space</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Strategic Data Mining and Database Development for Research Projects at Lake Mead, Nevada-Arizona USA (Pollard, J. and Andrew, G.)</td>
</tr>
<tr>
<td>L1</td>
<td>Surface Water Monitoring for Fecal Indicator Bacteria in High-use Site of the Lake Mead National Recreation Area (Cruz, P. et al.)</td>
</tr>
<tr>
<td>L2</td>
<td>Monitoring Water Quality on the Overton Arm of Lake Mead and its Tributary Inflows during Flood Flows (Arufe, J.)</td>
</tr>
<tr>
<td>R1</td>
<td>Keeping Fountain Grass Out of the Mojave Desert (Deuser, C. and Tietjen, R.)</td>
</tr>
<tr>
<td>R2</td>
<td>Athel (<em>Tamarix aphylla</em>) and Athel Hybrid (<em>Tamarix aphylla X Tamarix ramosissima</em>) Establishment and Control at Lake Mead National Recreation Area (Norman, C. et al.)</td>
</tr>
<tr>
<td>C1</td>
<td>Wastewater to Drinking Water: Are Emerging Contaminants Making it Through? (Alvarez, D. and Jones-Lepp, T.)</td>
</tr>
<tr>
<td>C2</td>
<td>Contaminant Flux in Las Vegas Bay: Are Sediments a Sink or Source? (Alvarez, D. and Rosen, M.)</td>
</tr>
<tr>
<td>C3</td>
<td>Endocrine Disrupting Contaminants in Common Carp from Lake Mead (Echols, K. et al.)</td>
</tr>
<tr>
<td>C4</td>
<td>Assessment of Endocrine and Gonadal Condition of Male Large-mouth Bass from Lake Mead, Nevada (Patiño, R. et al.)</td>
</tr>
<tr>
<td>C5</td>
<td>Testing of Las Vegas Municipal Effluent (Clark County, Nevada) for Endocrine and Reproductive Effects to Fathead Minnow (Deng, X. et al.)</td>
</tr>
<tr>
<td>C6</td>
<td>Diversity of Estrogen Degrading Microorganisms in Las Vegas Wash and Lake Mead, Nevada, USA (Blunt, S. et al.)</td>
</tr>
<tr>
<td>C7</td>
<td>History of Contaminant Inputs into Lake Mead Derived from Sediment Cores (Rosen, M. et al.)</td>
</tr>
<tr>
<td>C8</td>
<td>Tracing the Sources of Uranium in the Colorado River Basin (Sanchez, C. et al.)</td>
</tr>
</tbody>
</table>
### Sessions at a glance

**WEDNESDAY MORNING • January 14, 2009**

<table>
<thead>
<tr>
<th>Time</th>
<th>BALLROOM</th>
<th>ROOM 208</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 - 8:35 am</td>
<td>SESSION OPENING</td>
<td>SESSION OPENING</td>
</tr>
<tr>
<td>8:35 - 9:00 am</td>
<td>Lake Mead Razorback Sucker Recruitment: An Informative Anomaly Regarding Continued, Natural, Wild Razorback Sucker Recruitment Despite Non-native Fish Presence (Kegerries, R. et al.)</td>
<td>Revegetation Efforts along the Las Vegas Wash, Nevada (Eckberg, J. and Shanahan, S.)</td>
</tr>
<tr>
<td>9:25 - 9:50 am</td>
<td>The History of Threadfin Shad in Lake Mead and Their Importance to the Sport Fishery (Beckstrand, M.)</td>
<td>Assessing the Potential for Noxious Aquatic Plant Invasions of Lake Mead (Schlickeisen, E. et al.)</td>
</tr>
<tr>
<td>9:50 - 10:05 am</td>
<td>BREAK</td>
<td>BREAK</td>
</tr>
<tr>
<td>10:05 - 10:30 am</td>
<td>Value of Original Data Sets for Interpreting Ecological Trends for Lake Mead (Burke, T.)</td>
<td>Inventory and Temporal Variation of Aquatic Birds Using Lakes Mead and Mohave (Barnes, J. and Jaeger, J.)</td>
</tr>
<tr>
<td>10:30 - 10:55 am</td>
<td>Threadfin Shad and Invasive Quagga Mussels in Lake Mead, Nevada (Loomis, E. et al.)</td>
<td>Modeling Habitat for Gila Monster (<em>Heloderma suspectum</em>) Over Large Landscapes (Boykin, K. and Conrad, P.)</td>
</tr>
<tr>
<td>11:20 - 11:45 am</td>
<td>The Contemporary Food Web Structure of Two Bays in Lake Mead (Umek, J. et al.)</td>
<td>Southwestern Willow Flycatcher Habitat and Demographic Studies along the Virgin and Muddy Rivers, Lake Mead, and Lower Colorado River Regions: 2003 to 2007 (Koronkiewicz, T. and McLeod, M.)</td>
</tr>
<tr>
<td>11:45 am - 1:15 pm</td>
<td>Buffet Lunch at the UNLV Dining Commons</td>
<td></td>
</tr>
</tbody>
</table>

**WEDNESDAY AFTERNOON • January 14, 2009**

<table>
<thead>
<tr>
<th>Time</th>
<th>BALLROOM</th>
<th>ROOM 208</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:15 - 1:20 pm</td>
<td>SESSION OPENING</td>
<td>SESSION OPENING</td>
</tr>
<tr>
<td>1:20 - 1:45 pm</td>
<td>Pharmaceuticals in Waste Streams and Surface Waters of the Colorado River Basin (Sanchez, C. et al.)</td>
<td>Boulder Basin Adaptive Management (Turner, K. et al.)</td>
</tr>
<tr>
<td>1:45 - 2:10 pm</td>
<td>Use of Passive Samplers for Assessing Synthetic Organic Contaminants in Lake Mead National Recreation Area, Nevada and Arizona, USA (Goodbred, S. et al.)</td>
<td>Development and Application of a Three-Dimensional Water Quality Model to Lake Mead (Hannoun, I. et al.)</td>
</tr>
<tr>
<td>2:10 - 2:35 pm</td>
<td>Occurrence of Pharmaceuticals, Personal Care Products, and Potential Endocrine Disrupting Compounds in Lake Mead, NV (Trenholm, R. et al.)</td>
<td>Water Quality, Endocrine Disruption, and Fishes in Lake Mead: Reconnaissance Analysis of Competing Risks as Inputs for Developing Adaptive Management Plans (Linder, G. and Little, E.),</td>
</tr>
<tr>
<td>2:35 - 3:00 pm</td>
<td>Mercury Concentrations in Muscle Tissue from Sportfish in Lake Mead, Nevada (Kramer, J. et al.)</td>
<td>Nutrient Budgets for Lake Mead (Holdren, G.)</td>
</tr>
<tr>
<td>3:00 - 3:25 pm</td>
<td>BREAK</td>
<td>BREAK</td>
</tr>
<tr>
<td>3:25 - 3:50 pm</td>
<td>Study of Male Fish Gamete Quality to Assess Fish Health in Lake Mead National Recreation Area (2007) (Jenkins, J. et al.)</td>
<td>Initial Management Response to the Quagga Mussel Invasion of Lake Mead and the Lower Colorado River (Dingman, S.)</td>
</tr>
<tr>
<td>4:40 - 5:00 pm</td>
<td>Panel Discussion</td>
<td>Panel Discussion</td>
</tr>
<tr>
<td>5:00 - 6:00 pm</td>
<td>Poster / Exhibit Session (Ballroom)</td>
<td></td>
</tr>
</tbody>
</table>
On January 6, 2007, the quagga mussel (*Dreissena bugensis*) was found in Boulder Basin of Lake Mead. This is the first known occurrence of dreissenid species in the western United States. Upon this emerging issue, the National Park Service started to monitor the population dynamics at different spatial and temporal scales in Lake Mead. Before the end of January, adult mussels were found within all of the Boulder Basin and in the extreme western side of the Virgin Basin. No mussels were found in the Overton Arm, Gregg Basin, and Temple Bar areas. In Lake Mohave, mussels were only found in the southern section below the Cottonwood Basin. By the end of 2007, mussels had been found throughout lakes Mead and Mohave. The density of quagga mussels has been determined at 138 locations in Lake Mead. The average density in year 2007 was 505 ± 667 mussels/m². There were more mussels in rocky areas than silty areas. The discovery of the quagga mussel (*Dreissena bugensis*) was in Lake Mead, Nevada-Arizona has left researchers and lake managers with many daunting tasks related to monitoring the species’ impact on the normal ecology of the lake. This experiment tested the quagga mussel’s preference for substrate types in order to develop a monitoring plan for Lake Mead. Six materials were tested including high density polyethylene (HDPE) white plastic, ABS black plastic, concrete underlayer board (CUB), aluminum, stainless steel and fiberglass. Substrates were cut into 4 inch squares and placed at 5m intervals from 5m to 55m deep in a modified Latin square design in the Boulder Basin of Lake Mead near Sentinel Island. Since May 2008, substrates were removed and replaced with new substrates every two months for a total of four sampling events. All of the materials had mussel colonization, but colonization depended on substrate type and depth. Depths from 10-20 m experienced 4-12 times the number of mussels settled than lower depths. Aluminum and CUB were the preferred choice for mussel settlement, however it was difficult and time consuming to count the number of mussels on CUB, so this is not a recommended substrate for the monitoring plan. Stainless steel plates had smaller mussel counts than other materials. Based on the data presented in this paper, we will propose a monitoring plan for Lake Mead and make suggestions to industries that use Lake Mead water.

With invasion of quagga mussels into Lake Mead, there is a need to investigate their growth and recruitment to monitor their population dynamics. Mussels from 2 to 9 mm in shell length were held individually in a cage in Las Vegas Boat Harbor at 7.5 m from July 31, 2007 to March 19, 2008. The shell length measurements indicate that smaller mussels grew faster than larger ones. It took a mussel 110 days to grow from 2.5 to 10 mm. The maximum shell length was 18.9 mm. Another experiment was conducted based on those cohorts settling on ABS plastic pipes suspended in two lines: seven pipes in Line 1 in shallow water (6.4 - 9.1 m) since November 23, 2007 and eight pipes in Line 2 in deep water (8.2 - 18.6 m) since January 3, 2008. Length frequency was measured during each sampling. There are two major cohorts on each pipe and one of the cohorts was always dominated by the newly settled juveniles (84%). Therefore, the recruitment is very active. The shell length of the populations between these two lines didn’t show significant difference, though the estimated maximum shell length of mussels from Line 1 and Line 2 were estimated to be 16.0 and 11.2 mm, respectively. Mortality was observed when the mussels are around 10 mm or even smaller. The information on population dynamics from this study can be used by lake managers to evaluate their impacts on water quality, food webs, and public facilities.

The discovery of the quagga mussel (*Dreissena bugensis*) in Lake Mead was an issue that use Lake Mead water. The phytoplankton communities for 20 stations in the basins of Lake Mead were monitored quarterly from November 2006 through November 2008 coincident with the expansion of quagga mussel populations. Total phytoplankton biovolume in Lake Mead displayed seasonal fluctuations with peak biovolumes in May and August in 2007 and 2008. Total phytoplankton biovolume was strongly correlated with chlorophyll biovolume, however, the late summer total phytoplankton biovolume peaks were driven at many sampling locations by cyanobacterial blooms. Total phytoplankton biovolume was strongly correlated with chlorophyll a concentrations but the correlation between cyanobacterial biovolume levels and chlorophyll a was weak, suggesting that species level algal identification is necessary to monitor potentially harmful cyanobacterial blooms.
Quagga mussel veliger biomass was positively correlated with cyanobacterial biovolume at some stations in Boulder Basin. Increased cyanobacterial levels, specifically Microcystis, have been documented in other lakes where invasive mussels have been established for longer periods of time. Monitoring Microcystis is especially important due to potential toxicity and may cause taste and odor problems with drinking water. Based on the progression of mussel infestations in other systems, a potential expectation over time is that the biovolume of cyanobacteria (e.g., Microcystis) and heterotrophic bacteria will increase in importance in the water column. Using veliger abundance as a surrogate of quagga success, some regions of Lake Mead are approaching concentrations of mussels found in the Great Lakes where the Microcystis events/shifts have occurred.

3:15 – 3:40 pm • Ballroom
Potential Ecological Consequences of Invasion of the Quagga Mussel (Dreissena bugensis Andrusov 1897) into Lake Mead
Wong, David1; Tietjen, Todd2; Gerstenberger, Shawn1; Mueting, Sara1; and Loomis, Eric1 (1) University of Nevada, Las Vegas (2) Southern Nevada Water Authority

The invasion of Lake Mead by quagga mussels has the potential to change the ecosystem as impacts are propagated through the system. With increases in abundance and distribution, quagga mussels can transfer particulate matter from the water to benthic environments efficiently. Concentrations of chlorophyll will likely decrease and phytoplankton composition will shift as grazing resistant and benthic forms dominate. Zooplankton biomass will likely decrease because of increased competition and direct consumption on small species by quagga mussels. The Lake Mead fishery may be impacted as sport fish and their prey are limited by the diversion of resources. Some species like the common carp can use quagga mussels as food and may benefit as productivity is diverted to the benthos. Over the long term, nutrient dynamics may be altered by quagga mussel activity as epilimnetic concentrations shift, and as nutrients are buried along with quagga mussel pseudofeces. Water transparency and aquatic macrophytes may increase in areas where phytoplankton and other suspended particles are reduced. Benthic production overall will increase as quagga mussels flourish, but other benthic species may suffer. Oxygen in the hypolimnion will decrease due to respiration by quagga mussels and the bacteria associated with their pseudofeces. The pelagic concentrations of metals and organic pollutants will decrease as quagga mussels accumulate these materials. The magnitude and persistence of these changes will be influenced by a complex combination of the dynamics of the quagga mussels, water level fluctuations, and alterations to discharge and withdrawal characteristics. This manuscript is designed to help lake managers better understand and manage Lake Mead.

3:40 – 4:05 pm • Ballroom
The Ecology of Cultural Resources: Issues and Impacts Related to Submerged and Emergent Cultural Resources at Lake Mead National Recreation Area
Seeb, Sami K. and Choate, David
NPS Submerged Resources Center

With many pressing issues affecting the ecological health of Lakes Mead and Mohave, it is easy to overlook the impacts to cultural resources. However, when examined on a more practical level, it becomes clear that one cannot meaningfully address the ecological health of man-made lakes without exploring cultural resources as well. It is human behavior that created the lakes in the first place, and ultimately, it is human behavior that creates the ecological parameters within which impounded rivers develop and evolve. People have inhabited the shores of the historic Colorado River for thousands of years. The submerged and emerging cultural resources within Lake Mead NRA provide tangible evidence of this human interaction with the landscape. Natural impacts initiated and intensified by human behavior are affecting the cultural resources scattered on the lake bottom and surrounding shorelines. Investigating impacts to submerged and emergent cultural resources provides a unique avenue to gain insights that might not be otherwise discovered. Specifically, invasive aquatic species and drought have dramatic effects on the cultural resources within the park and both are at least partly the result of human activity. The quagga mussel infestation is already showing signs of physical damage to submerged cultural resources and research suggests additional unseen impacts to the cultural materials and their surrounding environment. Lowering water levels also result in impacts to cultural resources. Assessing these impacts will facilitate understanding of issues impacting ecological health locally, and on a broader scale, world-wide.

4:05 – 4:30 pm • Ballroom
Will Quagga Mussels Potentially Impact the Native Species’ Food Web in Lake Mead by Affecting Plankton and Nutrient Availability?
Link, Carolyn L.; Acharya, Kumud; and Papelis, Lambis
Desert Research Institute

Zebra and quagga mussels have had extensive ecological impact on the Great Lakes because of their large filtering capacity and high density. By filtering considerable amounts of water they effectively remove plankton biomass from the water column. Subsequent mussel waste increases ammonia levels present benthically and pelagically. Based on experience from the Great Lakes and Mississippi Basin, it is likely that the invasion of the plankton filtering quagga mussels (Dreissena bugensis) into Lake Mead will shift the food web away from native species either by decreasing the plankton biomass or changing nutrient conditions to favor other plankton species. The objectives of this laboratory study focus on quantification of algal clearance rates and ammonia excretion as a function of size of mussels and food concentrations. Prior to study commencement mussels were collected, acclimated to laboratory aquaria, and physically classified. Algal and ammonia concentrations were determined by measuring spectral absorbance and then comparing measurements to a pre-calibrated curve relating absorbance to concentration as determined with a Lachat QuickChem Autoanalyzer. The expected filtration results will aid characterization of the extent quagga mussels may impact Lake Mead’s benthic and pelagic food webs by changing algal biomass and lake clarity.
The Lake Mead fishery is one of great importance to both sport fishermen and conservationists seeking to protect the native razorback sucker. Previous research suggests the sport fishery is largely driven from benthic production (see Umek et al.; this program, page 12). However, no quantitative information exists regarding the contemporary composition and production of zoobenthos. This information is even more critical given the recent introduction of invasive quagga mussel to the lake in order to gauge future change and potential opportunities for restoration. In this study, we present the current composition, biomass, and changes in zoobenthic production over two time periods. Also, we briefly review the effect of quagga mussels on other limnetic ecosystems and present findings that describe their current distribution, population size structure, and energetics (pelagic to benthic coupling) with depth.

LIMNOLOGY AND WATER QUALITY
Session Chairs:
Todd E. Tietjen and Michael Lico
Tuesday • 1:15 pm to 5:00 pm • Room 208

1:20 – 2:45 pm • Room 208
What Are We Discharging?
Schiefer, Scott H., City of Las Vegas

Since 1979, the Nevada Division of Environmental Protection has required the wastewater treatment agencies in the Las Vegas Valley to monitor the ambient water quality of the Las Vegas Wash and Lake Mead. In the early days, the dischargers began performing the monitoring themselves. Currently, the monitoring is handled under a cooperative agreement between the City of Las Vegas (CLV), the Clark County Water Reclamation District (CCWRD), and the City of Henderson (CoH). The CLV collects samples and performs field measurements at the Lake, the CCWRD analyzes the samples from the Lake, and the CoH performs all aspects of monitoring the Wash.

The sampling program has changed over the years due to different demands, emerging issues and the lowering lake levels. Recently, to prepare for the Systems Conveyance and Operations Program (SCOP), a pipeline that will take most of the wastewater treatment plant effluent out of the Wash and discharge it deep in Boulder Basin through diffusers near the Boulder Islands, the extent of the monitoring of the Lake has nearly doubled. The purpose for the increased monitoring is to establish background conditions in the Lake, especially around the mixing zone established for the diffusers.

The data that have been collected over the years includes secchi depth, temperature, conductivity, pH, dissolved oxygen, light extinction, zooplankton, phosphorus, total suspended solids, total dissolved solids, ammonia, nitrate, nitrite, colloforms, chlorophyll-a, and color.

1:45 – 2:10 pm • Room 208
The U.S. Geological Survey’s Lake Mead Monitoring Network
Veley, Ronald J.; Fisher, Lawrence H.; and Wiersma, Danielle M., U.S. Geological Survey

Studies are currently underway to determine temporal changes and spatial distributions of natural and anthropogenic chemical compounds in Lake Mead. Water-quality monitoring networks at Lake Mead have been established by several federal, state, and local entities. These networks have focused on common constituents such as major ions, trace metals, nutrients, and selected anthropogenic compounds such as perchlorate. Recently, reservoir models have been developed to gain a better understanding of circulation patterns (hydrodynamics) and associated transport of chemicals in the lake. Moreover, data-collection networks and models for Lake Mead have provided an understanding of areas where baseline data are sparse or areas where additional data on chemical or physical parameters are needed.

To assist with these efforts to better understand the lake’s dynamics, the U.S. Geological Survey (USGS), in cooperation with the National Park Service, Southern Nevada Water Authority, and Clark County Water Reclamation, collects water-quality, water-velocity, and meteorological data as part of its Lake Mead Monitoring Network.

The USGS maintains five platforms on the lake at: Las Vegas Bay, near Sentinel Island, Virgin Basin, Temple Basin, and Overton Arm. At each platform, depth dependent measurements of specific conductance, pH, water temperature, dissolved oxygen, turbidity, and percent fluorescence are collected every six hours. The provisional near-real-time water-quality data are placed online at: http://nevada.usgs.gov/lmqw/index.htm. Quality assured water-quality data for the platforms can also be accessed at this website. In addition, water-velocity and meteorological data are collected hourly at each platform.

2:10 – 2:35 pm • Room 208
Evaluation of Water Quality Monitoring Instruments with Cooperative Interagency Sampling Events in Lake Mead
Turkett, Warren B., Southern Nevada Water Authority

Every year government agencies spend a considerable amount of funds on monitoring programs to determine water-quality parameters. In Lake Mead there are at least eight agencies collecting data with portable water-quality instruments. The data collected are used to make important decisions for lake managers, so it is important the data are comparable between agencies. After our first coordinated sampling event on February 13, 2007, the results showed significantly different data between agencies. Two sources of error that were identified were differences between instruments and differences created by operator error. Two additional sampling events were scheduled to further investigate the source of variability. During the investigation, we examined the most commonly used multi-probe instruments for water-quality monitoring manufactured by Eureka, Hydrolab, and YSI. We examined water column profiles for pH, conductivity, temperature, and dissolved oxygen between the instruments over three coordinated sampling events. The results will be presented along with an assessment of some of the most common factors that contribute to variable data. Calibration protocol, maintenance schedules, and operator error...
Abstracts

will be discussed to help achieve greater data consistency between agencies.

2:35 – 3:00 pm • Room 208
Long Term Patterns in the Diversity and Composition of Phytoplankton in Las Vegas Bay, Lake Mead
Tietjen, Todd
Southern Nevada Water Authority

The Southern Nevada Water Authority has collected integrated, near surface phytoplankton samples from sites along a transect from the confluence with the Las Vegas Wash out into the open waters of Lake Mead since May of 2000. These samples have been analyzed in order to determine the species composition and biovolume of phytoplankton as part of routine monitoring in order to document the occurrence of taste and odor causing algae, to identify the dominant species during periods with algal blooms, and to maintain a record of the species that are present. In this presentation evidence of changes in species diversity that have occurred over this time period will be presented in addition to changes that are observed along the longitudinal gradient from the Las Vegas Wash out into the open water. Additionally these changes will be related to other ecosystem parameters that have been measured simultaneously. While specific events like the Pyramichlamys bloom that occurred in 2001 capture the attention of the public, long term trends can be more informative about changes that are occurring in Las Vegas Bay overall. As the lake enters a period with multiple stressors: continued fluctuation of lake levels, the increasing dominance of the invasive quagga mussel (Dreissena bugensis), and potential shifts in nutrient loading to the lake, it is important to evaluate past patterns in order to be prepared for future changes.

3:15 – 3:40 pm • Room 208
TDS and Selenium Projections in the Las Vegas Wash post Implementation of the Systems Conveyance and Operations Program (SCOP)
Ryan, Roslyn and Zhou, Xiaoping, Southern Nevada Water Authority

Urban runoff in the Las Vegas Valley flows into the Las Vegas Wash (Wash) via several major tributaries, contributes approximately 7-10% of the total Wash flow, and has a significant impact on water quality in the Wash and Lake Mead. Urban runoff entering the Wash contains higher total dissolved solids (TDS) and higher selenium (Se). With effluents from three wastewater treatment plants in the valley that significantly dilute the more saline urban runoff and shallow groundwater, TDS concentrations in the Wash are currently suitable for the growth of diverse plants and Se concentrations are below the EPA recommended level (<5g/L) for fish and wildlife. With the population growth and the wastewater effluent increases in the valley, the Systems Conveyance and Operation Program (SCOP) has been implemented to divert the majority of effluent into a pipeline that directly discharges into the Boulder Basin of Lake Mead, effluent flow to the Wash and the resulting dilution factor will be significantly reduced, primarily affecting TDS and Se concentrations. Using the data collected by the SNWA water quality team and a mass-balance model, projections have been made to predict what TDS and Se concentrations can be expected with different effluent flows to the Wash post implementation of the SCOP. These projections will help to develop a management plan to keep TDS concentrations sustainable for the established ecosystems and Se concentrations below the EPA standards for fish and wildlife.

3:40 – 4:05 pm • Room 208
Characterization of Dissolved Organic Matter from Lake Mead by Liquid Chromatography Quadrupole Time of Flight Mass Spectrometry
Mawhinney, Douglas B.; Rosario-Ortiz, Fernando L.; Baik, Seungyun; Vanderford, Brett J.; Snyder, Shane
(1) Southern Nevada Water Authority (2) University of Colorado (3) University at Buffalo

Dissolved organic matter (DOM) occurs naturally in surface water due to the decomposition of plant and animal matter. The makeup of DOM can vary based geographical location, as well as seasonal changes in the flora and fauna present in or near the body of water. Such changes are particularly important to understand from a drinking water standpoint, as they can affect the demand for oxidants used in the disinfection process, as well as the profile of by-products formed. Liquid chromatography quadrupole time-of-flight mass spectrometry (LC-QTOF MS) was employed to characterize DOM standard materials sourced from different locations around the world, as well as samples from Lake Mead and its tributaries. It was found that this technique was most sensitive to the fulvic acid fraction of DOM, and resulted in very complex data. Principle component analysis was employed to simplify the analysis of these data, and it was found that the major differences between samples were related to the relative polarity and nitrogen content of the materials. Specific characterization data for each of the standard materials and samples will be presented, and possible implications will be discussed.

4:05 – 4:30 pm • Room 208
SCOP Marine Investigations Field Program
MacKinnon, Angela I. and Orphan, Lynn
(1) MWH Americas, Inc. (2) Clean Water Coalition

The Marine Investigations Field Program of the Systems Conveyance and Operations Program (SCOP) will be comprised of two tasks: (1) investigation of the sediment thickness in the area of the five diffuser discharge points and (2) investigation of the ability of quagga mussels to attach to HDPE pipe.

The purpose of the sediment thickness task is to investigate the thickness of the post-impoundment sediment at the five outfall discharge locations. Earlier measurements of the thickness of the post-impoundment sediment on the bottom of Lake Mead indicate that the sediment may be 12-inches to as much as 7-feet thick in the area of the proposed pipeline alignment. The sediment thickness task will be developed and implemented whereby a rectangular weight is placed on the lake bottom in these areas. A remotely operated vehicle (ROV) will be utilized to observe post-impoundment sediment thickness and characteristics by capturing underwater video. The purpose of the quagga mussel task is to investigate and observe the potential for quagga mussels to attach to HDPE pipe. The quagga mussel task will be implemented by placing test sections of HDPE pipe on the lake bottom and on the surface.

The results of the Marine Investigation Field Program will be used to make recommendations for the design and operation of the Boulder Islands Outfall pipelines. This paper will discuss preliminary results of the Marine Investigations Field Program.
EQuIS 5 LakeWatch is the latest technology available for effectively managing and analyzing lake or reservoir monitoring data. Based upon the well-known LakeWatch software package designed by one of the world’s preeminent limnologists, Dr. Noel Burns of New Zealand, EQuIS 5 LakeWatch is used to manage Lake Mead monitoring data and designed to display, analyze, and interpret trends in water quality. Using a robust and industry-standard SQL Server or Oracle database backend, EQuIS 5 LakeWatch directly imports data from the previous version of LakeWatch, as well as files from numerous data loggers such as HydroLab, RUSS, Licor, and Campbell Scientific.

In cooperation with the Southern Nevada Water Authority (SNWA), Lake Mead data will be presented illustrating both characteristics of Lake Mead and highlighting features of the software. In addition to visually depicting sample and profile events and allowing the user to graphically and intuitively establish epi-thermo and thermo-hypo interfaces, EQuIS 5 LakeWatch includes many useful reports including a Trophic Level Index (TLI) report and a Hypolimnetic Volumetric Oxygen Depletion (HVOD) report. New features include enhanced tools for creating vertical profile diagrams as well as isopleths.

### AQUATIC BIOTA AND FISHERIES

**Session Chairs:**

Erik Orsak and Jon Sjöberg

**Wednesday • 8:30 am to 11:45 am • Ballroom**

#### 8:35 – 9:00 am • Ballroom

**Lake Mead Razorback Sucker Recruitment:**

**An Informative Anomaly Regarding Continued, Natural, Wild Razorback Sucker Recruitment Despite Non-native Fish Presence**

Kegerries, Ron B.; Albrecht, Brandon; and Holden, Paul B. BIO-WEST, Inc.

An ongoing razorback sucker (*Xyrauchen texanus*) research project on Lake Mead, Arizona and Nevada has been funded by the Southern Nevada Water Authority and the U.S. Bureau of Reclamation for 12 years. This study continues to document the continued presence of wild razorback sucker recruitment in the form of young, sexually immature individuals. This recruitment denotes the Lake Mead razorback sucker population as an anomaly in terms of razorback sucker persistence throughout the Colorado River drainage, despite similar non-native fish composition and densities as other locations. Fin ray aging data and back-calculation techniques have indicated that recruitment of razorback sucker on Lake Mead has occurred nearly every year. It was once thought that high lake elevations coincided with high recruitment. However, beginning with the 2007 spawning period we have captured individuals spawned during low-water years.

We believe that cover, both vegetative and in the form of turbidity, provides protection and food resources for larval and juvenile razorback sucker, thereby enabling them to avoid predation by non-native sport fish present in the system. Interestingly, it appears as though turbidity may be even more important than we have typically considered. As monitoring efforts on Lake Mead continue we hope to further document wild recruitment, and perhaps begin to understand more fully how to enable this unique trend in other locations. We suggest that Lake Mead provides a view of what naturally recruiting razorback sucker populations look like in the real world of nonnative predators.

#### 9:00 – 9:25 am • Ballroom

**The Development of the Lake Mohave Striped Bass (*Morone saxatilis*) Fishery and its Impact on the Threadfin Shad (*Dorosoma petenense*) Population and the Stocked Rainbow Trout (*Oncorhynchus mykiss*) Fishery**

Burrell, Michael D., Nevada Department of Wildlife

In 1980 Lake Mohave sport fishing was supported by a stocked rainbow trout fishery and a self reproducing population of largemouth bass (*Micropterus salmoides*) and channel catfish (*Ictalurus punctatus*). There was a large population of threadfin shad. Striped bass were never intentionally stocked. They are believed to have entered the lake through angler introductions or more likely by passing through or over Hoover Dam as eggs, larvae, or possibly older life stages. They were first documented in Lake Mohave in the early 1980’s. Reproduction was documented by the mid 1980’s. By 1990 they had become the primary sport fish. The striped bass population is comprised primarily of fish less than 50cm. The availability of medium size forage is limited. The result is poor recruitment of fish greater than 50cm. A small percentage, however, does pass through the forage bottleneck and can grow to exceptional size by utilizing stocked trout and carp as forage. As the striped bass population grew they quickly eliminated threadfin shad. Unlike Lake Mead, Lake Mohave lacks the turbid inflows that provide refuge areas where a core population of shad can be maintained. By 1996 threadfin shad were essentially gone. As the number of large striped bass increased in the mid 1980s the stocked rainbow trout fishery declined quickly. Predation by striped bass and an angler preference change from rainbow trout to striped bass resulted in declining harvest numbers. Stocking procedures evolved to adapt to the deleterious effects of the growing striped bass population.

#### 9:25 – 9:50 am • Ballroom

**The History of Threadfin Shad in Lake Mead and Their Importance to the Sport Fishery**

Beckstrand, Mark, Nevada Department of Wildlife

The threadfin shad (*Dorosoma petenense*) is a member of the herring family (*Clupeidae*). Threadfin shad are native to the southeastern United States but have been widely introduced to waters outside their native range. They have become a popular species for use in creating a forage base for larger game fish. Lake Mead supported an excellent warm water fishery after its formation in 1935. But by 1941, fishermen of the area became concerned when many of the largemouth bass were found to be thin and in poor condition. This poor condition was thought to result from a lack of adequate forage species. Threadfin shad were first released into Lake Mead in 1954 and by 1956 had become established throughout the reservoir. Soon after the successful introduction of threadfin shad to Lake Mead, all species of game fish were found to be utilizing shad as forage, which resulted in better body condition and growth for those species. To-
day, threadfin shad are the principle forage species for game fish in Lake Mead. But, recent introductions of gizzard shad (Dorosoma cepedianum) and the quagga mussel (Dresieina bugensis) to Lake Mead pose potential threats to this important species and, in turn, have a negative impact on the whole sport fishery of Lake Mead.

10:05 – 10:30 am • Ballroom
Value of Original Data Sets for Interpreting Ecological Trends for Lake Mead
Burke, Thomas A., U.S. Bureau of Reclamation

The recent invasion of Lake Mead by the exotic quagga mussel has spawned research and monitoring actions to assess the ecological impact of this new species. The first step is to acquire and review the existing baseline data about the physical, chemical and biological conditions of the Lake Mead prior to this invasion. As the outcome of the assessment will be influenced by the interpretation of these historical data, it is paramount that researchers review the original data or data-sets, and not the summarized data, in conducting their analyses. Case studies are presented for two Lake Mead data sets wherein investigators failed to review the original data, resulting in erroneous conclusions. The first case compared limnetic zooplankton densities of Lake Mead across a ten year period (1971-1980), concluding that a six-fold decline had occurred. It was later found that the original 1971 data-set presented numbers of zooplankton per sample, not per liter and that the sampler used was a six-liter Van Dorn bottle, hence no six fold change in the community. In the second case, sport fish creel data for Lake Mead, showed a harvest of over 890,000 largemouth bass in 1963, which declined to 360,000 by 1974. Coincidentally, Lake Powell began filling in 1963. These harvest data were instrumental in acquiring funding for a five-year black bass study. Investigations after the study was completed found the original 1963 estimate to be in error. Due to funding limits, creel methods and analyses were modified in 1963, roughly doubling the harvest estimate. In each case no malice was intended. The authors of the original data had not misrepresented it. However, the investigators who later reached back in time, extracted only the data summaries. Had an adequate review been conducted on the original data-set, these original data would not have been misrepresented.

10:30 – 10:55 am • Ballroom
Threadfin Shad and Invasive Quagga Mussels in Lake Mead, Nevada
Loomis, Eric; Wong, David; and Gerstenberger, Shawn
University of Nevada, Las Vegas

The recent introduction of the invasive bivalve quagga mussel (Dresieina bugensis) has the potential to impact trophic food webs and the aquatic environment. Shad are the primary forage fish for striped bass, largemouth bass, and channel catfish and may exert great influences over this system. It’s unclear what the effects of quagga mussels will have on the fishery. The lake has already seen massive changes in zooplankton abundance and distribution. Larval and adult threadfin shad (Dorosoma petenense), which utilize zooplankton as a critical food source, have been collected in Las Vegas Bay and Overton Arm, Lake Mead through joint cooperation with the Nevada Department of Wildlife and funded through the National Park Service. This study is to determine feeding habits and health status (k-factor), as well as diets of shad since the mussel invasion. As quagga mussels proliferate throughout Lake Mead, the food chain could be altered in a manner that threatens the sport fishery by removing the most important forage fish in the lake—threadfin shad. The abundance of shad in 2008 is one of the two lowest data points in an 18-year record, though the overall trend is not clear. This study will serve as a baseline of projected long-term monitoring programs through various inter-agency involvement related to the recent invasion of quagga mussels to the southwest.

10:55 – 11:20 am • Ballroom
Response of the Algal Community in Boulder Basin, Lake Mead to the Introduction of Quagga Mussels and Reduced Water Levels
St. Amand, Ann, L.; Roefer, Peggy; LaBounty, James, F.; Bolt, Dustin, M. (1) PhycoTech, Inc. (2) Southern Nevada Water Authority

Algal data were analyzed at several surface stations in Boulder Basin, Lake Mead from 2002-2008. Stations ranged from the Las Vegas Bay to just upstream of the Hoover Dam and included a variety of sites, including the intake for the drinking water treatment plant at depth. The volume of the reservoir has been declining in recent years, although water treatment efforts have substantially decreased input nutrients, especially phosphorus (1994 and 2006 forward). Quagga mussels (Dresieina rostriformis bugensis) were first detected in Lake Mead in January 2007, but archival samples indicated that the mussels had been present at low levels since at least November 2006. Quagga and zebra mussels have been associated with a shift towards toxin-producing Cyanophytes in other systems, including the Great Lakes, and have also been associated with ecosystem changes relating to zooplankton food supply. Both raw data (density, total biovolume, total area, total volume, GALD) and water quality indices and ratios were analyzed correlating results to several key environmental variables (water level, surface temperature, salinity, nutrient levels), and the invasion of quagga mussels. In addition to total community indicators, several species/genera were also used in the analysis including Pyramichlamys cordiformis (Tetraselmis), Ceratium hirundinella, Cylindropermopsis raciborskii, Aphanizomenon flos-aquae, Microcystis aeruginosa, Cyclotella comta var. bodanica, Cyclotella ocellata, and several key species of picoplankton that have become increasingly important since 2005 (Cyanograniis ferruginea and Cyanocatena plantonica). Both time series analysis and multidimensional scaling analysis (Primer 6) were used to explore ecological relationships among algal indicators and environmental variables.

11:20 – 11:45 am • Ballroom
The Contemporary Food Web Structure of Two Bays in Lake Mead
Umek, John1; Chandra, Sudeep1; Rosen, Michael2; Goodbred, Steven2; Orsak, Erik1 (1) University of Nevada, Reno (2) U.S. Geological Survey (3) U.S. Fish and Wildlife Service

Lake Mead is the largest man-made lake in the United States and supports a robust recreational fishery. There is little contemporary information, however, regarding the ecology and food-web structure of the lake. This study provides a contemporary snapshot of the zooplankton and benthic invertebrate community and the lake’s food-web structure in two bays: Overton Arm and Las Vegas Bay. Special emphasis is placed on understanding the biomass of primary and secondary producers. Benthic invertebrate biomass was greater in Overton Arm than Las Vegas Bay with variability over two seasons. Zooplankton biomass was variable in time and space.
across the bays. The food-web structure determined from stable isotope measurements (carbon and nitrogen) and stomach-content data suggests that the bottom habitats drive both Las Vegas Bay and Overton Arm food webs, and shad do not contribute to the large game, striped bass (*Morone saxatilis*) and large mouth bass (*Micropterus salmoides*), energetics. Carp, a model surrogate species used to assess exposure of emerging contaminants obtain most of their energy from the benthic invertebrate community, not from the bottom algae or plants in both bays.

### RIPARIAN AND SHORELINE RESOURCES

**Session Chairs:** Scott Abella, Jef Jaeger, and Cris Tomlinson  
**Wednesday • 8:30 am to 11:45 am • Room 208**

**8:35 – 9:00 am • Room 208**  
**Revegetation Efforts along the Las Vegas Wash, Nevada**  
Eckberg, Jason R. and Shanahan, Seth A.,  
Southern Nevada Water Authority

The Las Vegas Wash is the most substantial riparian area in the Las Vegas Valley and it is the primary drainage channel for this 1,600 square-mile watershed that drains to Lake Mead. During the last few hundred years, the most significant flows in the Las Vegas Wash came from periodic stormwater runoff from the valley. Currently, the Las Vegas Wash has a consistent base flow of more than 150 million gallons per day which comes from a combination of highly treated wastewater discharge, urban runoff, and groundwater seepage. Exponentially increasing base flows in the Las Vegas Wash created approximately 2000 acres of wetlands by the 1970s. These wetlands, however, have been reduced substantially by erosion. In 1998, the Las Vegas Wash Coordination Committee was formed to address stabilization and enhancement activities along the Las Vegas Wash. Over the past 10 years, extensive revegetation projects have been implemented to complement mechanical stabilization initiatives. These projects have enhanced ecosystem services such that wildlife habitat and aesthetic values have improved substantially. Nearly 200 acres have been actively planted along the Las Vegas Wash. Planning efforts, procedures, monitoring results and planned future revegetation activities will be presented.

**9:00 – 9:25 am • Room 208**  
**Monitoring Wintering Bald Eagles at Lakes Mead and Mohave: Assessing Historic Data, Improving Counts, and Modeling Habitat Use**  
Jaeger, Jef R.; Raskin, Morgan; Fletcher, Dawn M.; Joseph Hutcheson; Sappington, J. Mark, (1) University of Nevada, Las Vegas and (2) NPS Lake Mead National Recreation Area

Lakes Mead and Mohave are favored stop-over areas during bald eagle winter migrations in the western United States. Each January since 1985, personnel from Lake Mead National Recreation Area have participated in a Midwinter Bald Eagle Count in support of a national effort to measure population size and distribution. Unfortunately, count methods have varied over the years resulting in data which are inconsistent and potentially misleading. Since 2001, efforts have been made to standardize count methodologies and to better train personnel in both identification and recording techniques. Herein we describe what meaningful information can be derived from the historical data, how these counts were improved by standardizing protocols, and what can now be derived from more recent data. To better understand habitat use on Lake Mead, we used location and activity data collected during counts in 2007 and 2008 to create distribution maps and habitat use models. We evaluated habitat variables representing food availability, shelter, and human disturbance. Results indicate that distribution and habitat use varied between the two years, probably in response to differences in weather conditions during the counts. Bald eagles appear to have selected habitat which provided greater shelter from inclement weather during the count in 2007, whereas during good weather in 2008 eagles appear to have selected habitat which provided greater foraging potential along shorelines. By improving our count data, we hope to better understand temporal variation in numbers and to gain insight into distribution and habitat use on Lakes Mead and Mojave.

**9:25 – 9:50 am • Room 208**  
**Assessing the Potential for Noxious Aquatic Plant Invasions of Lake Mead**  
Schlickeisen, Erica; Dibble, Eric; and Tietjen, Todd.

Lake Mead has recently been colonized by the invasive quagga mussel and the impacts of this species are only now becoming apparent. It is likely that these mussels were accidentally introduced to the lake by recreational boaters or by passive transport through the Colorado River system. It is important to consider the vulnerability of the Lake Mead ecosystem to other potential invaders; already found in the region are a wide variety of invasive aquatic plants that can have profound impacts. Among the common invasive plants currently impacting lakes of the western United States, Lake Mead is susceptible to invasion by Giant Reed (*Arundo donax*) Hydrlia (*Hydrlia verticillata*), Eurasian Water Milfoil and Parrotfeather (*Myriophyllum* sp.), Alligator Weed (*Alternanthera philoxeroides*), Curly leaf pondweed (*Potamogeton crispus*), and Giant Salvinia (*Salvinia molesta*). A review of conditions in Lake Mead suggest that while extensive colonization of the lake is unlikely given the extremely steep shorelines, deep water column, fluctuating water levels, and relatively low nutrient concentrations; several popular bays and beaches have the potential to be invaded. The accumulation of sediments, nutrient inputs from inflows, wind conditions, relatively shallow depths, deep light penetration and the high potential for local introductions (boat ramps) in these areas may lead to invasive plant issues. We will review limnological and morphometric conditions in conjunction with data related to recreational use in order to develop a framework for assessing the potential risk of invasion.

**10:05 – 10:30 am • Room 208**  
**Inventory and Temporal Variation of Aquatic Birds Using Lakes Mead and Mohave**  
Barnes, Joseph G. and Jaeger, Jef, R.  
University of Nevada, Las Vegas

The creation of Lakes Mead and Mohave in the 1930s and 1950s impounded water along 140 river miles of the Colorado and Virgin Rivers. These large reservoirs substantially changed aquatic and shoreline habitats which subsequently attracted aquatic birds not previously known to frequent the region in large numbers. We report here on a multiyear inventory of aquatic bird species on these two reservoirs and on temporal variation in species composition and...
numbers over a five-year period. In 2004, we began monthly surveys at four sites on Lake Mead and three sites on Lake Mohave that represented areas of high aquatic bird activity. We tallied 93 aquatic bird species and 17 species of raptor. For summary, we classified species into nine foraging guilds: aerialists, diving carnivores, diving omnivores, herbivores, marsh birds, raptors, shorebirds, and waders. Both reservoirs show high seasonal variation in overall abundance, species and guild assemblages, and include regionally substantial numbers of wintering and migrating birds. Overall, more than 112,000 birds of 103 species were tallied on Lake Mead during the monthly surveys. On this reservoir, herbivores and diving carnivores were the most abundant guilds, and the top five most abundant species accounted for over 53% of all records. In contrast, Lake Mohave was dominated by one herbivore species, the American coot, which accounted for over 81% of the more than 32,000 recorded birds of 66 species. These data establish a baseline of aquatic bird use on these lakes, which will be critical in evaluating future trends.

10:30 – 10:55 am • Room 208
Modeling Habitat for Gila Monster (Heloderma suspectum) over Large Landscapes
Boykin, Kenneth G.¹ and Conrad, Paulette M.²
(1) Cooperative Fish & Wildlife Research Unit
(2) Nevada Department of Wildlife

Conservation of species is dependent on fine and coarse-scale assessments with habitat modeling often providing the coarser scale. The Gila monster (Heloderma suspectum) is protected in every U.S. state in which it resides but is losing considerable amounts of habitat in rapidly expanding areas such as southern Nevada, southwestern Utah and throughout Arizona. Given the difficulty in observing this elusive species in the field, a habitat model can identify potentially suitable H. suspectum habitat that can inform mitigation actions, especially where significant habitat loss would result from proposed land development or use activities. Inductive (species occurrence based) and deductive (knowledge based) models have strengths and weaknesses. We created an inductive habitat model for H. suspectum using species occurrence points obtained from state wildlife agencies in Arizona, Nevada, New Mexico and Utah, and online museum databases. We used regional environmental variables of meso-scale and relative fine resolution (30m). We ran six model iterations and identified a model consisting of elevation, distance to springs, land cover, and landform as providing the best model based on Area Under the Curve (AUC) and omission rates. We then compared our model with the Southwest Regional Gap Analysis Project deductive model. Though both models identified much of the same habitat, the inductive model was more limited and provided more detailed habitat information that could be useful to managers and researchers interested in the conservation of H. suspectum.

10:55 – 11:20 am • Room 208
Long-term Monitoring of Bat Populations Associated with Extensive Riparian Restoration in Las Vegas Wash, Clark County, Nevada
O’Farrell, Michael J.; Shanahan, Seth; Foster, Marissa
(1) O’Farrell Biological Consulting (2) Southern Nevada Water Authority

This is a progress report of a long-term continuous monitoring program that was initiated in January 2004 to establish baseline inventory and habitat use of bats in Las Vegas Wash. This study provides baseline conditions in a currently highly disturbed riparian corridor, which is in the beginning stages of an extensive riparian restoration project. Continued monitoring through the restoration process will be able to document the effects of restoration process on the resident and transitory bat community. Three acoustic monitoring stations were established at approximately 1.6km intervals in the wash allowing collection of data all night every night. Locations were selected to reflect the variations in habitat composition and structure found within the wash. A total of 17 species of bats have been recorded; three species were previously known from a single historic record and six species were not known to occur within Las Vegas Valley, including a species new to the State. Patterns of occurrence and intensity of use are forming. Marked differences of use by various species have been found among the three monitoring sites. Continued monitoring will allow determination of annual variations in occurrence and use due to changing weather patterns as well as the effects of riparian restoration.

11:20 – 11:45 am • Room 208
Southwestern Willow Flycatcher Habitat and Demographic Studies along the Virgin and Muddy Rivers, Lake Mead, and Lower Colorado River Regions: 2003 to 2007
Koronkiewicz, Thomas J. and McLeod, Mary Anne
SWCA Environmental Consultants

From 2003 to 2007, we have been conducting habitat and demographic studies of the Southwestern Willow Flycatcher at Pahranagat NWR, along the Virgin and Muddy Rivers, within Lake Mead NRA and Grand Canyon, and along the Colorado River and tributaries south to the Mexico border. We found resident and breeding flycatchers in eight study areas. Nest sites had taller canopy, greater canopy closure, and greater vertical foliage density above the nest layer compared to non-use locations. Nests were closer to water/saturated soil than were non-use locations, and were located in areas exhibiting higher humidity and a smaller daily temperature range when compared to non-use locations. Of the flycatchers banded as juveniles and detected as adults, 59% returned to the same study area and 41% returned to a different study area. For adults that were detected in multiple years, 92% returned to the same study area while 8% returned to a different study area. Movement data indicate juvenile dispersal among local populations is largely limited to within river drainages, and most dispersal distances are 30 km or less. Adult survival varied by geographical area but not by year. Juvenile survival was lower than that for adults, but models did not indicate that juvenile survival varied significantly between geographic areas. Results of this long-term study have been successful in providing restoration practitioners goals for creating flycatcher breeding habitat.
A number of pharmaceuticals have been detected in surface waters across the United States. The objective of this study was to evaluate the presence of selected pharmaceuticals (macrolidic antibiotics and pseudoephedrine) and illicit drugs (methylamphetamine, Ecstasy) in surface waters of the Colorado River basin. Grab samples were collected spatially and temporally from waste stream tributaries and receiving surface waters within the basin in Colorado, Utah, Nevada, Arizona, and California. At selected locations we also used time-weighted polar organic chemical integrative samplers (POCIS). Grab samples were prepared for analysis using an automated extractor (AutoTrace, Caliper Life Sciences) with Oasis MCX cartridges (Waters Corp.), subsequently extracted with 5 mLs of 80:20:1 methyl tertbutyl ether/methanol/acetic acid, and 5 mLs 99:1 methanol/acetic acid, and reduced to 0.5 mL using an automated evaporator (TurboVap-Zymark, Caliper Life Sciences). Recovery of the analytes from the POCIS sorbent was achieved by transferring the sorbents into glass gravity-flow chromatography columns fitted with glass wool plugs and stopcocks. Methanol was used to elute the pharmaceuticals from the sorbent. All extracts were analyzed with a Varian 500MS ion trap mass spectrometer by performing real-time mass analyses of LC eluents. One or more of the pharmaceuticals and/or illicit drugs evaluated were found in urban waste streams at concentrations close to method reporting limits. Several compounds were quantified by isotope dilution with method reporting limits ranging from 0.2 to 120 ng/L. More than 50% of the compounds were detected in Las Vegas Wash samples. However, less than 20% of the compounds were detected in samples collected from the Colorado River downstream of the Hoover Dam and at concentrations close to method reporting limits. Several contaminant concentrations were graphed to show how the plume of wastewater effluent exiting the Las Vegas Wash mixes with the lake water and is further carried down the Colorado River.

By another musk fragrance, tonalide (9.5 ng/L). Both compounds were only detected in LVW downstream of effluent outfalls (galaxolide, 400 ng/L; tonalide, 41 ng/L). Galaxolide was detected at a low concentration (1.3 ng/L) in Boulder Basin (=20 km from most upstream detection), but was not detected below Hoover Dam. Other SOCs detected, including legacy organochlorine compounds, were at much lower concentrations (<1 ng/L) but were detected at more sites. The spatial distribution of compounds detected indicates that the main source of SOCs is from LVW, but there are other sources within LMNRA. Evidence of endocrine disruption in several species of fish has been observed in LMNRA, including altered reproductive hormones, reduced gonadal development, and lower sperm quality indicating exposure to endocrine disrupting compounds.


date: Wednesday • 1:15 pm to 5:00 pm • Ballroom

Pharmaceuticals in Waste Streams and Surface Waters of the Colorado River Basin
Sanchez, Charles A.¹, Jones-Lepp, Tammy², Wilson, Doyle³, Alvarez, David A.⁴ (1) University of Arizona (2) U.S. EPA, National Exposure Research Laboratory (3) City of Lake Havasu (4) USGS Columbia Environmental Research Center

Many synthetic organic compounds (SOCs) pose potential toxicity to aquatic biota. Approximately 650,000 m³/day of tertiary treated wastewater from the Las Vegas metropolitan area flows through Las Vegas Wash (LVW), into Las Vegas Bay (LVB) which is part of Lake Mead National Recreational Area (LMNRA). Other sources of SOCs include irrigated-urban runoff, storm-water runoff, subsurface inflow and accidental spills. A wide variety of SOCs have been previously found in bottom sediment, fish tissue, and water in LMNRA. Passive samplers were deployed in LMNRA to determine spatial distribution and potential SOC sources. A commonly used musk fragrance, galaxolide, was found in LVB at a higher concentration (90 ng/L) compared to other compounds detected (generally <2 ng/L), followed by another musk fragrance, tonalide (9.5 ng/L). Both compounds were only detected in LVW downstream of effluent outfalls (galaxolide, 400 ng/L; tonalide, 41 ng/L). Galaxolide was detected at a low concentration (1.3 ng/L) in Boulder Basin (=20 km from most upstream detection), but was not detected below Hoover Dam. Other SOCs detected, including legacy organochlorine compounds, were at much lower concentrations (<1 ng/L) but were detected at more sites. The spatial distribution of compounds detected indicates that the main source of SOCs is from LVW, but there are other sources within LMNRA. Evidence of endocrine disruption in several species of fish has been observed in LMNRA, including altered reproductive hormones, reduced gonadal development, and lower sperm quality indicating exposure to endocrine disrupting compounds.

Emerging contaminants such as pharmaceuticals, personal care products, pesticides and potential endocrine disrupting compounds are of concern as many of these could potentially exhibit health effects on wildlife at low concentrations. Many of these compounds enter the Lake Mead eco-system as a result of incomplete removal from wastewater treatment processes via the Las Vegas Wash. In an effort to better understand their occurrence and fate in Lake Mead, advanced analytical methods were developed for 51 emerging contaminants, which were used to monitor their concentrations. Water samples were collected from Lake Mead, the Las Vegas Wash and from the Colorado River, just below the Hoover Dam over a course of two years. Target compounds were extracted by automated solid phase extraction and analyzed by GC-MS/MS and LC-MS/MS. Most compounds were quantified by isotope dilution with method reporting limits ranging from 0.2 to 120 ng/L. More than 50% of the compounds were detected in Las Vegas Wash samples. However, less than 20% of the compounds were detected in samples collected from the Colorado River downstream of the Hoover Dam and were at concentrations close to method reporting limits. Several contaminant concentrations were graphed to show how the plume of wastewater effluent exiting the Las Vegas Wash mixes with the lake water and is further carried down the Colorado River.

Lake Mead is the largest man-made reservoir in the United States and provides fishing opportunities for numerous anglers. Considerable attention has been given to the bioaccumulation of methylmercury in fish tissues, however, no formal study utilizing approved EPA methodology has been conducted to quantify the amount of mercury present in fish tissue from Lake Mead. The purpose of this study is to determine the concentrations of mercury present in the most commonly consumed fish from Lake Mead and to identify if any of the 4 major basins contain fish with elevated concentrations of mercury. Large mouth bass (n=30), striped bass (n=90), channel catfish (n=44), and blue tilapia (n=31) were collected from selected

Lake Mead Science Symposium 2009
sites in Boulder Basin, Overton Arm, Virgin Basin, and Gregg Basin of Lake Mead by gill netting or electrofishing. Muscle tissue was homogenized, digested, and analyzed for mercury in accordance with EPA Method 245.6 which must be used to construct human health based fish consumption advisories. Initial findings indicated that mean mercury concentrations were 0.075±0.044 ppm, 0.146±0.103 ppm, and 0.093±0.075 ppm in largemouth bass, striped bass, and channel catfish, respectively. Mercury concentrations in blue tilapia were below the detectable limit for this method and therefore were not included in statistical analysis. Preliminary analyses indicated a significant difference (p= 0.001, F= 7.18) between mercury values among the three species. Post-hoc analysis indicated that striped bass contained significantly more mercury (p= 0.003) than largemouth bass but no significant difference was found in channel catfish. In the preliminary data, no significant difference (p= 0.026, F= 3.19) was found between mercury concentrations in fish collected from each of the four basins.

3:25 – 3:50 pm • Ballroom
Study of Male Fish Gamete Quality to Assess Fish Health in Lake Mead National Recreation Area (2007)
Jenkins, Jill A.1; Patiño, Reynaldo1; Goodbred, Steven L.1; Eilts, Bruce E.1; Draugelis-Dale, Rassa O.; Orsak, Erik L.; Rosen, Michael1 (1) U.S. Geological Survey (2) Louisiana State University, and (3) U.S. Fish and Wildlife Service
Animal survival, growth, and reproduction are essential parameters in environmental assessments. A measure of reproductive performance is gamete quality, relating to fertility. From 2006-2008, gamete quality was assessed in the Lake Mead National Recreation Area (LMNRA) using a recreational species, largemouth bass (Micropterus salmoides), endangered razorback suckers (Xyrauchen texanus), and common carp (Cyprinus carpio). In 2007, carp (n=11 to 15 per site), a subsample of a larger population (n=200), were collected from Overton Arm (OA, reference), Las Vegas Bay (LVB), Las Vegas Wash (LWV), and Willow Beach (WB) to investigate possible differences among sites. A significant site difference (P<0.0001) was noted in gonadosomatic index (GSI), where OA>LVB>LWV>WB. Exposure to EDC has been shown to negatively impact GSI, including previous studies with carp in LMNRA. Significantly lower mitochondrial membrane potential and higher percentages of apoptotic spermatozoa were noted at WB than at the other sites (P=0.0056; P<0.0001), respectively. Sperm counts were significantly higher at OA than at LWV (P=0.0270), with all other sites statistically intermediate, OA>(LVB=WB)>LWV. A number of studies have shown that exposure to EDC lowers sperm count which decreases fertilization rates. Sperm DNA fragmentation was higher at WB and LWV than at OA and LVB (P=0.0009). Sperm motility patterns, as measured by computerized sperm motion analysis, were not different. These gamete quality biomarker data were in general accord with endocrine and histological effects observed from the larger population of carp.

3:50 – 4:15 pm • Ballroom
Gonadal and Endocrine Condition of Male Common Carp in the Lake Mead National Recreation Area (2007-2008)
Patiño, Reynaldo1; Goodbred, Steven L.1; Orsak, Erik1; Jenkins, Jill A.1; Rosen, Michael R.1 (1) U.S. Geological Survey and (2) U.S. Fish and Wildlife Service
In Lake Mead National Recreation Area (LMNRA), Las Vegas Bay (LVB) receives municipal wastewater effluent, urban runoff, and resurfacing groundwater from the Las Vegas metropolitan area via the Las Vegas Wash (LWV). To examine potential effects of these anthropogenic inputs on fish condition within LMNRA, male common carp (Cyprinus carpio) were collected at four sites [Overton Arm, OA (reference site); LVB; LWV; and Willow Beach, WB] through one reproductive cycle (March, July, November 2007; March 2008) for determination of gonadal (reproductive) and endocrine status. OA males generally had higher gonadosomatic indices (gonad size), higher plasma 11-ketotestosterone (KT) and estradiol-17β (E2), and lower E2/KT ratio (except for WB, with ratios similar to OA). Fish condition in LWV seemed to be intermediate between OA and LWV, indicating a possible gradient of environmental effects within the lake. The condition of males at WB (downstream of Hoover Dam) generally deviated from the reference condition (OA) even more than males from LWV. Although seasonal patterns were evident for all four endpoints in OA and LWV males, no seasonal patterns were seen for KT and E2/KT ratios in LWV males, and no seasonal patterns were observed in WB males. In conclusion, the reproductive and endocrine status of male carp in LMNRA can be classified from high to low according to study site as follows: OA>LVB>LWV>WB. Insights concerning the nature of the factors responsible for site-dependent differences in the condition of male carp within LMNRA await the completion of ongoing physicochemical characterizations of the aquatic habitats.

4:15 – 4:40 pm
Low-level Emerging Contaminants in Lake Havasu, Arizona and California and their Access to Lake Havasu City’s Drinking Water Supply
Wilson, Doyle C.1 and Lepp-Jones, Tammy L.2 (1) City of Lake Havasu, Lake Havasu, AZ (2) U.S. Environmental Protection Agency
In preparation of a wastewater effluent re-charge and recovery program involving alluvial fan sediments, the City of Lake Havasu initiated a survey to evaluate possible waterborne sources of emerging contaminants in the water/wastewater distribution cycle. This distribution cycle includes Lake Havasu water (raw and treated well water), treated wastewater, and ambient groundwater where effluent injection and subsequent groundwater withdrawals will take place. The results from Lake Havasu (raw and treated) water analyses are discussed here. Grab samples were taken once per quarter over a year and were analyzed by liquid chromatography-mass spectrometry (LC-MC) at Southern Nevada Water Authority’s (SNWA) River Mountain Research Facility and at the U.S. Environmental Protection Agency’s (EPA) Las Vegas National Exposure Research Laboratory (NERL). Several pharmaceutical compounds (atenolol, caffeine, carbamazepine, dilantin, meprobamate, primidone, and sulfamethoxazole), the herbicide atrazine, and the insect repellent DEET have been consistently present in ultra-low concentrations (ng/L range) in the Colorado River, above the urbanized areas of Lake Havasu and in Lake Havasu’s Thompson Bay adjacent to Lake Havasu City. Further, the concentrations of these compounds at each of the two locations are comparable, and vary little seasonally. Several other compounds analyzed such as MDMA and TCEP are more episodic. Raw source well water, which has filtered through at least 80 feet of subsurface gravels and sands below the lake bottom, contains six of the above compounds, of which sulfamethoxazole is apparently extracted during the city’s biological manganese removal, potable water treatment process. Concentrations of the other five constituents in the finished treated water are largely unchanged.
**Lake Management**

**Session Chairs:**
Kent Turner and Chris Holdren

**Wednesday • 1:15 pm to 5:00 pm • Room 208**

### Boulder Basin Adaptive Management

**Turner, Kent**; Orphan, Lynn; and Karafa, Doug (1) NPS Lake Mead NRA (2) Clean Water Coalition

The Boulder Basin Adaptive Management Program (BBAMP) manages the treated effluent of Las Vegas to meet water quality objectives for the Las Vegas Wash, Lake Mead and the Colorado River downstream. Currently three municipal wastewater discharges are permitted into Lake Mead: 150 MGD from Clark County Water Reclamation District, 91 MGD from City of Las Vegas and 40 MGD from City of Henderson. Discharges are conveyed through the Las Vegas Wash, which also conveys Las Vegas storm water.

The Clean Water Coalition (CWC) was formed in 2002 by the dischargers to plan alternatives to their effluent discharges to Las Vegas Wash. The CWC proposed through an Environmental Impact Statement for a new effluent diffuser system to include a diffuser pipeline.

Through the EIS process, NPS, BOR and FWS developed mitigation requirements documented in the record of decision and biological opinion. These include a selenium management plan for the Las Vegas Wash, a Fathead Minnow study to predict impacts to Razorback Suckers in Lake Mead, and implementation of an adaptive management program for the BBAMP. The BBAMP outlines a monitoring program and as management process to ensure that project goals related to water quality and resource protection are met.

The BBAMP is managed by a core management team of the CWC, SNWA, Reclamation, NPS, and FWS. The main functions were assigned to four technical advisory teams comprised of representatives from local, state and federal agencies with responsibility for water resources, water quality and use of Lake Mead, the Las Vegas Valley watershed, and the Colorado River downstream.

### Development and Application of a Three-Dimensional Water Quality Model to Lake Mead

**Hannoun, Imad A.; Preston, Al; Kavanagh, Kristen B.; List, E. John**; Orphan, Lynn; Turner, Kent; Roefer, Peggy (1) Flow Science Incorporated, (2) Clean Water Coalition, (3) NPS Lake Mead National Recreation Area, and (4) Southern Nevada Water Authority

The three-dimensional Estuary, Lake and Ocean Model (ELCOM), coupled with Computational Aquatic Ecosystem DYnamic Model (CAEDYM) were applied to the simulation of water quality in the entire Lake Mead. Eight years of extensive field measurements of water quality parameters in the reservoir were used as inputs to the model, and to provide comparisons between the model results and field data. Good agreement was obtained for various modeled parameters including temperature, salinity, perchlorate, nutrients (nitrogen and phosphorus), and chlorophyll a. The model will be used as an integral part of an adaptive management plan for the lake. It is anticipated that the model will be used to evaluate various future lake operating scenarios and assist in management decisions for optimizing the various uses of the reservoir under the adaptive management plan. The presentation will show comparisons between the model and the field data. It will also provide animations that will highlight the complex limnological processes within the reservoir, including the inflows from the Colorado, Virgin and Muddy Rivers and Las Vegas Wash, and the outflows through Hoover Dam and the various water supply intakes. The model results proved to be a valuable resource for understanding the interactions between the various reservoir processes and for defining the seasonal characteristics of the reservoir.

### Water Quality, Endocrine Disruption, and Fishes in Lake Mead: Reconnaissance Analysis of Competing Risks as Inputs for Developing Adaptive Management Plans

**Linder, Greg and Little, Edward E.**
USGS/BRD, Columbia Environmental Research Center

Competing risks play a critical role in developing adaptive management plans for natural resources. For water resources, the analysis and characterization of competing risks relies on a wide spectrum of analytical tools to evaluate hazards and risks associated with anticipated uses of water resources. For waters of the lower Colorado River that are stored in reservoirs such as Lake Mead on the Arizona-Nevada border, a wide range of water quantity and water quality challenges confront resource managers. These issues are often interdependent and complicated by competing uses of source waters for sustaining biological resources and for supporting a range of agricultural, municipal, recreational, and industrial uses. USGS is currently conducting a series of interdisciplinary studies on water quality of Lake Mead and its source waters. In this case-study we examine selected constituents potentially entering the Lake Mead system, particularly endocrine disrupting chemicals (EDCs). A number of potential EDCs have been detected in Lake Mead, and several substances have been identified that are of concern because of potential impacts to the aquatic biota, including the sport fishery of Lake Mead and endangered razorback suckers that occur in the Colorado River system. To identify potential linkages between EDCs and species of management concern, the risk analysis and characterization in this reconnaissance study focused on effects (and attendant uncertainties) that might be expressed by exposed endemically populations. In addition, risk reduction measures potentially of interest to resource managers are considered relative to emerging contaminants in treated effluents, interdependencies among biological resources “at risk”, and uses of reservoir waters derived from multiple inflows of widely varying qualities.

### Nutrient Budgets for Lake Mead

**Holdren, G. Chris, U.S. Bureau of Reclamation**

Available information on nutrient concentrations, tributary inflows, and outflows for Lake Mead were used to develop nutrient budgets for the lake. As expected, the Colorado River, which contributes approximately 96% of the annual inflow to the lake, was the largest single source of nutrients. Las Vegas Wash contributes less than 2% of the total inflow but contributes more than 5% of the total phosphorus and more than a third of the soluble orthophosphate enter-
Abstracts

Quagga mussels, closely related to zebra mussels, were first discovered at Lake Mead on January 6, 2007, the first detection of this species in the western United States. These invasive freshwater mussels were expected to cause, and indeed have started to realize, major impacts to biological resources, submerged cultural resources, marinas, water intakes, boats and recreational use in the Lower Colorado River System and, when spread, pose similar threats to other western waters. The National Park Service’s Lake Mead National Recreation Area led a three month interagency initial response effort focused on assessment, containment, treatment, and long-term management of the quagga mussel infestation in Lakes Mead and Mohave. This effort culminated in an Initial Response Plan. When no treatment or eradication methods were found to be feasible, the efforts focused on containment of spread to other watersheds. Highlights of this initial response effort as well as lessons learned the hardway will be shared in this presentation by the Initial Response Coordinator.

3:50 – 4:15 pm • Room 208
Initial Management Response to the Quagga Mussel Invasion of Lake Mead and the Lower Colorado River
Dingman, Sandee J., NPS Lake Mead NRA

Quagga mussels were discovered and has grown rapidly to include about 80 individuals representing over 25 agencies. Significant progress has been made by combining efforts, providing current data to the group, standardizing methodology and carefully examining the objectives and requirements of the different agencies. The results of these efforts will be compiled and integrated into an interagency quagga mussel plan targeting the long term monitoring of veligers, juveniles, and adults. Based on group discussions, we will primarily focus on 18 stations in Boulder Basin, the most heavily monitored area of Lake Mead. This program can be implemented by lake managers and stakeholders to scientifically monitor the long-term quagga mussel development and its ecological consequences on water quality and food webs in Lake Mead.

4:15 – 4:40 pm • Room 208
Interagency Response to Quagga Mussel Invasion at Lake Mead: Detection, Prevention, Control, and Monitoring
Gerstenberger, Shawn1; Turner, Kent2; and Wong, David1
(1) University of Nevada, Las Vegas and (2) NPS Lake Mead NRA

Quagga mussels (Dreissena bugensis) were found on January 6, 2007 in Lake Mead and constitute one of the first occurrences of dreissenid mussels (quagga and zebra mussels) in the western United States. Multiple agencies have expressed concerns about protecting drinking water quality, water delivery infrastructure, ecosystem health, endangered species, recreational activities, and identifying ways to reduce the spread of this invasive species. To address these issues, a small working group was established shortly after quagga mussels were discovered and has grown rapidly to include about 80 individuals representing 25 agencies. Significant progress has been made by combining efforts, providing current data to the group, standardizing methodology and carefully examining the objectives and requirements of the different agencies. The results of these efforts will be compiled and integrated into an interagency quagga mussel plan targeting the long term monitoring of veligers, juveniles, and adults. Based on group discussions, we will primarily focus on 18 stations in Boulder Basin, the most heavily monitored area of Lake Mead. This program can be implemented by lake managers and stakeholders to scientifically monitor the long-term quagga mussel development and its ecological consequences on water quality and food webs in Lake Mead.

3:25 – 3:50 pm • Room 208
Whole Lake Manipulation for Controlling Quagga Mussels in Southern California Reservoirs
Taylor, William D. and DeLeon, Ricardo
Metropolitan Water District of Southern California

Since quagga mussels were first reported in Lake Mead in January 2007, they spread from the Colorado River throughout the 250 mile storage and conveyance system of the Metropolitan Water District of Southern California and into San Diego County to within a few miles of the Mexican border affecting the water supply of 18 million people. Metropolitan has been developing numerous approaches to manage the mussels in the conveyance side of the system for trash racks, pumping plants, aqueducts, pipelines, etc. During 2008, Metropolitan conducted two whole lake experimental manipulations designed to kill mussels in the reservoirs. The first strategy relies on enhancing lake stratification, a natural process that can lead to anoxia and mussel death in the hypolimnion. The second strategy was to draw down the reservoirs to kill mussels in the upper reaches through desiccation. The intent of the combined approaches was to reduce mussel populations and disrupt reproductive cycles. The approach took advantage of operational options available in engineered systems that can be used to manipulate lake processes. Both Lake Mathews and Lake Skinner developed anoxia that successfully killed hypolimnetic mussels at depths inaccessible to divers for cleaning. Also, low oxygen conditions appeared to stress mussels above the kill zone and interfere with spawning. Desiccation will clearly kill mussels. Risks associated with these whole lake manipulations include increasing availability of nutrients to algae blooms and taste-and-odor events, manganese releases from sediments, fish kills and water quality conditions incompatible with treatment plant processes.

3:50 – 4:15 pm • Room 208
Whole Lake Manipulation for Controlling Quagga Mussels in Southern California Reservoirs
Taylor, William D. and DeLeon, Ricardo
Metropolitan Water District of Southern California

Since quagga mussels were first reported in Lake Mead in January 2007, they spread from the Colorado River throughout the 250 mile storage and conveyance system of the Metropolitan Water District of Southern California and into San Diego County to within a few miles of the Mexican border affecting the water supply of 18 million people. Metropolitan has been developing numerous approaches to manage the mussels in the conveyance side of the system for trash racks, pumping plants, aqueducts, pipelines, etc. During 2008, Metropolitan conducted two whole lake experimental manipulations designed to kill mussels in the reservoirs. The first strategy relies on enhancing lake stratification, a natural process that can lead to anoxia and mussel death in the hypolimnion. The second strategy was to draw down the reservoirs to kill mussels in the upper reaches through desiccation. The intent of the combined approaches was to reduce mussel populations and disrupt reproductive cycles. The approach took advantage of operational options available in engineered systems that can be used to manipulate lake processes. Both Lake Mathews and Lake Skinner developed anoxia that successfully killed hypolimnetic mussels at depths inaccessible to divers for cleaning. Also, low oxygen conditions appeared to stress mussels above the kill zone and interfere with spawning. Desiccation will clearly kill mussels. Risks associated with these whole lake manipulations include increasing availability of nutrients to algae blooms and taste-and-odor events, manganese releases from sediments, fish kills and water quality conditions incompatible with treatment plant processes.
“Water 2025” is a Department of Interior initiative designed to guide the management of scarce water resources in the American West. As an important Colorado River reservoir, Lake Mead is a fundamental component of Water 2025. For Water 2025 to achieve its goals, comprehensive knowledge is needed of historic and current Lake Mead water quality data. A task agreement between the National Park Service and the University of Nevada, Las Vegas, provides for a strategic data mining project to identify research and monitoring projects on Lake Mead that have been conducted in the past, prioritize relevant projects, and ensure data availability by converting the data to an electronic format.

Discussed here are the results of the comprehensive literature search and construction of the Access data base developed in phase one of the project. The literature search focused on the topics of: water quality, limnology, contaminants, fisheries, aquatic biota, and riparian/shoreline resources. The database was created to serve as a repository for descriptive metadata for Lake Mead research projects. Metadata is structured to allow refined searches for project results with sub-headings such as: research topics, research locations, parameters measured, and date or duration of research. A ranking system is being developed which will allow for prioritization of data mining activities and capture of electronic data during the project’s second phase. The ultimate goal of this project is to make historic data more available to the managers and researchers working towards meeting the goals of Water 2025.

**L1** Surface Water Monitoring for Fecal Indicator Bacteria in High-use Site of the Lake Mead National Recreation Area

Cruz, Patricia1; Stevens, Vanessa L.1; Rinella, Jessie J.1
(1) University of Nevada, Las Vegas (2) NPS Lake Mead NRA

The Lake Mead National Recreation Area incorporates 1.7 million acres, including Lake Mead and Lake Mohave. The abundance of recreational activities on Lakes Mead and Mohave can impact the contaminant levels in the water, potentially affecting the health of individuals in contact with the water. The purpose of this study was to review and synthesize information obtained for projects conducted by partner agencies from the Water 2025 Conservation Initiatives, specifically bacterial concentration in high-use areas. Surface water samples were collected from May and September, at 9 high-use sites from 2003 to 2007. Culture analysis was performed to determine the concentration of fecal coliforms, Enterococcus, fecal Streptococcus, and Escherichia coli. Test results of 324 water samples analyzed for *E. coli* showed only one instance of a concentration higher than the acceptable limit. Enterococci concentrations above the acceptable limit were found in 13% of the samples (n= 165). In addition, 9% of 317 samples exceeded the acceptable limit for fecal Streptococcus, and fecal coliforms were present in concentrations above the acceptable limit in 3% of the 324 samples analyzed. Throughout the 4-year study, two sites, Boxcar Cove and 6-Mile Cove, were identified as those with the highest frequency of unacceptable levels of the indicator organisms monitored. The results of this study will be used to address the technical soundness of monitoring at the Lake Mead National Recreation Area, and will identify management recommendations to the National Park Service.

**L2** Monitoring Water Quality on the Overton Arm of Lake Mead and its Tributary Inflows during Flood Flows

Arufe, Jorge A., U.S. Geological Survey

The U.S. Geological Survey (USGS), in cooperation with the National Park Service (NPS) and the Bureau of Reclamation (BOR), is determining temporal changes and spatial distributions of natural and anthropogenic compounds entering the Overton Arm of Lake Mead. These efforts and others already underway on the lake by BOR, USGS, and the Southern Nevada Water Authority (SNWA) will aid in the development of a reservoir model of the lake. The effects of flood flows on the water quality of the Overton Arm are largely unknown and necessary for model development.

Water quality physical parameters (water temperature, pH, specific conductance, dissolved oxygen, and turbidity) are continuously monitored near the mouth of the Virgin and Muddy Rivers using multi-parameter sondes. Water samples also are collected quarterly at both sites and analyzed for major ions (and bromide), trace elements, nutrients, pesticides, suspended sediment (concentration and sand/silt break), total organic carbon, and indicator bacteria.

During flows that exceed the 1.5-year flood, data collection intensifies. Water samples are collected at both river sites and analyzed for the same constituents as quarterly samples and hourly suspended sediment samples are collected with an automatic sampler over a 24 hour period. Additionally, changes in sediment load and water quality in Lake Mead are monitored during these flood events by: 1. Measuring water temperature, pH, specific conductance, dissolved oxygen, and turbidity profiles on a transect of seven sites in the Overton Arm, and 2. Collecting water samples at the epilimnion, thermocline, and hypolimnion of each of the profile sites for low-level nutrients, arsenic, bromide, total organic carbon, and total suspended sediment concentration. The same transect is sampled by BOR monthly during base flow conditions.
populations in 2001. Control is also occurring on adjacent U.S. Fish and Wildlife Refuges by the National Park Service. Lake Mead Exotic Plant Management Team through partnership agreements. Nevada designated fountain grass on the State Noxious Weed List in 2002, and one of the largest commercial nurseries in the state voluntarily withdrew it from sales prior to listing. Populations of this weedy grass have dramatically declined due to successful control actions.

**Abstracts**

**R2** Athel (*Tamarix aphylla*) and Athel Hybrid (*Tamarix aphylla X Tamarix ramosissima*) Establishment and Control at Lake Mead National Recreation Area

Norman, Carrie M., Deuser, Curtis E., Hoines, Josh, Lake Mead NRA

Athel is a large evergreen ornamental tree that has been planted throughout the Southwest since the 1950s. Athel was considered benign because it was thought to produce non-viable seed unlike its invasive relative, tamarisk. However, athel began establishing in the wild from seed on Lake Mead in 1983. Lake Mead National Recreation Area (Lake Mead NRA) has been actively controlling athel since November 2004 along the high water mark of Lake Mead shoreline (439 miles) to prevent it from spreading throughout the Colorado River drainage. The National Park Service contracts Nevada Conservation Corps crews and the Lake Mead Exotic Plant Management Team to implement the control efforts for these species. Since 2004 Lake Mead NRA has controlled 72, 156 athel and 11, 749 hybrids. Control methods have been effective and follow-up monitoring and retreatment is planned during the 2009 field season. Based on observations at Lake Mead NRA, the invasive potential of athel is high, particularly in light of its hybridization potential with tamarisk thus creating a new noxious weed. Natural resource land managers should be vigilant in monitoring current athel populations to ensure they do not become invasive or hybridize with tamarisk.

**C1** Wastewater to Drinking Water: Are Emerging Contaminants Making it Through?


Lake Mead serves as the primary drinking water source for Las Vegas, Nevada and surrounding communities. Besides snow-melt from the Rockies water levels in the lake are supplemented by the inflow of treated wastewater from communities along the Colorado River, including Las Vegas. This use-reuse practice is becoming commonplace in the arid Southwest and begs the question: Are organic contaminants, originating in the wastewater, ending up in the drinking water? In 2005, a study was conducted using passive sampling devices (SPMDs and POCIS) to track the occurrence of trace amounts of pharmaceuticals and personal care products, pesticides, industrial chemicals, and chemicals characteristic of wastewater treatment plant (WWTP) effluents at two sites in Las Vegas wash (LVW), one site near Hemingway Harbor in Lake Mead, and in finished drinking (tap) water within the City of Las Vegas. As predicted, the largest abundance and highest concentrations of targeted chemicals were present at the second site in LVW downstream of the confluence of three WWTP effluents. Two antibiotics, azithromycin and clindamycin, along with two illicit drugs, methamphetamine and Ecstasy, were measured in LVW along with numerous pesticides and chemicals indicative of WWTP effluents. Several pesticides were detected above background levels in the drinking water sample at concentrations of 10 to 97 pg/L. Data from the yeast estrogen screen (YES) correlated with the chemical measurements as the highest estrogenic potential was measured in samples from the LVW. Hemingway Harbor and the drinking water samples did not have a measurable estrogenicity above background levels.

**C2** Contaminant flux in Las Vegas Bay: Are sediments a sink or source?


Treated wastewater effluent from Las Vegas, Nevada and surrounding communities flows through Las Vegas Wash into Lake Mead at Las Vegas Bay (LVB). Lake sediment is a likely sink for many organic wastewater contaminants (OWCs); however, partitioning between the sediment and the overlying water could result in the sediment acting as a secondary contaminant source. Passive sampling devices (semipermeable membrane devices-SPMDs and polar organic chemical integrative samplers-POCIS) were placed in LVB between June and July of 2008 to determine the vertical gradient of OWCs in the water column and potential contribution of OWCs from the sediment. A custom deployment housing was used to bury the SPMDs and POCIS in the sediment at depths of 0-10, 10-20, and 20-30 cm. SPMDs and POCIS were also suspended in the water column at depths of 3.0, 4.9, and 6.7 (lake bottom) meters. Preliminary data indicates that the hydrophobic OWCs such as polycyclic aromatic hydrocarbons are twice as concentrated near the sediment-water interface as in the mid and upper water column. The YES assay, used to measure total estrogenicity, indicated that the chemicals sampled in the middle of the water column were twice as estrogenic as those in the upper portion and ten times as estrogenic as those near the sediment-water interface.

**C3** Endocrine Disrupting Contaminants in Common Carp from Lake Mead

Echols, Kathy R.; Rosen, Michael R.; Goodbred, Steven L.; Orsak, Erik (1) U.S. Geological Survey (2) U.S. Fish and Wildlife Service

Lake Mead provides drinking water and recreation for millions of people, and it provides habitat for fish and wildlife. Because of its multiple uses, water quality in the lake is vitally important. Over the past decade scientists have evaluated chemicals in the water, sediment and fish from Lake Mead, and have found synthetic organic chemicals. Recent studies evaluating biological endpoints have found evidence of endocrine disruption in male fish, specifically carp. For this study male common carp (Cyprinus carpio) were collected from four sites in and around Lake Mead – Las Vegas Wash, Las Vegas Bay, Overton Arm, and Willow Beach. Endocrine disrupting legacy chemicals were evaluated as well as emerging industrial and personal care product chemicals. The legacy chemicals determined were organochlorine pesticides and PCBs. Newer chemicals determined were polybrominated diphenyl ethers, fragrance compounds, triclosan and its derivatives, bisphenol A, and nonyl phenols. The pollutants were determined in whole fish using high resolution gas chromatography with three types of detection: high resolution mass spectrometry with selected ion monitoring (PBDEs, derivatized phenols, pesticides), quadrupole full-scan mass spectrometry (fragrances, triclosan derivatives) and electron capture detection (PCBs, pesticides).

**Students, be sure to visit the career table to learn more about careers in the NPS, SNWA, and USGS.**

Need assistance? Call 702-324-3105
In Lake Mead, Las Vegas Bay (LVB) receives tertiary treated wastewater effluent, urban runoff, and groundwater from the Las Vegas metropolitan area. This study examined the potential for endocrine disrupting effects of these anthropogenic inputs on male largemouth bass (Micropterus salmoides). Adult male bass were collected at two sites within Lake Mead: Overton Arm (OA, reference site), and LVB. Post-spawn fish were collected in July 2007 (n = 6-10 per site) and pre-spawn fish in March 2008 (n = 13 per site). Post-spawn fish were characterized by regressed testes whereas pre-spawn bass had ripe gonads. Mean fish lengths and weights did not vary between sites or sampling times. Significant site-associated differences in the endocrine and somatic condition of pre-spawn fish were noted. Pre-spawn LVB males had lower plasma 11-ketotestosterone, higher estradiol-17β, higher E2/KT ratio, higher hepatosomatic index (ratio of liver to body weight), higher hematocrit values, and higher condition factor compared to OA males. However, no significant differences were evident in the gonadosomatic index (ratio of testes to body weight) of either pre- or post-spawn males from the two sites. In post-spawn males, no significant site-associated differences were detected for any of the parameters measured. Overall, these results suggest the existence of site-specific environmental influences on several indices of endocrine condition and health of pre-spawn male largemouth bass from Lake Mead, and are generally consistent with outcomes from previous studies that suggested the occurrence of altered endocrine and reproductive condition in LVB males of other species, such as common carp.

This project will use fathead minnow (Pimephales promelas) to examine the potential effects of tertiary-treated wastewater effluent on indices of fish endocrine and reproductive function. The studies will be conducted at the Clark County Water Reclamation District, Nevada. The test system will consist of flow-through exposure systems using two standard formats: the 21-day and 2-generation (6-month) protocols. These protocols use experimental units (tanks) containing 4 adult females and 2 adult males, and each treatment is conducted in quadruplicate. Endpoints measured will include a number of endocrine and reproductive fitness traits, including survival, spawning success, blood vitellogenin, and secondary sex characteristics. Conventional effluent will be tested at six dilutions: 0, 6.25, 12.5, 25, 50, and 100%. In addition, the effects of enhanced treatment of wastewater (by ultrafiltration and ozonation technologies) will also be examined and compared to the effects of conventional tertiary effluent in side-by-side trials. Tests will be conducted during winter and summer to determine if seasonal differences exist in wastewater quality. The information derived from this study will assist the efforts of (1) resource managers to assess the effects that municipal effluents at the concentrations found in the lake may cause to a native fish species, the federally endangered razorback sucker (Xyrauchen texanus); and (2) wastewater treatment plant managers to evaluate the status of current conventional tertiary treatment and the effectiveness of enhanced treatments for the removal of endocrine-disrupting compounds.

Endocrine disrupting chemicals (EDCs) are a subject of intense research as more studies reveal their persistence in the environment and detrimental effects on wildlife. Steroid hormones, including the natural and synthetic estrogens 17-beta-estradiol (E2) and 17-alpha-ethinyl estradiol (EE2), are among the most bioactive and have been detected at low concentrations in waterways downstream from wastewater treatment plants. Las Vegas Wash, a stream flowing into Lake Mead and fed primarily by treated wastewater, provides a unique experimental system in which to study the role microorganisms play in the fate and dispersal of these compounds in surface waters. The natural potential for biodegradation of the steroid hormones E2 and EE2 was examined utilizing native microorganisms from Las Vegas Wash and Lake Mead. Organisms from a variety of physiotypes, capable of mediating the degradation of E2 and EE2 while growing on their preferred substrates, were cultured and isolated from samples collected along a Las Vegas Wash--to-Lake Mead transect at base flow and identified using 16S rRNA gene sequencing. The abundance of culturable organisms capable of using these compounds as a sole carbon source was also assessed utilizing dilution cultivation and enrichment techniques. Compounds were reduced to levels below detection limits within 4 days. Terminal restriction fragment length polymorphism analysis (T-RFLP), a community DNA fingerprinting approach was used to explore the environmental abundance and diversity of microorganisms that play a role in determining the fate of these emerging contaminants.

Assessing the changes in contaminant inputs (both organic and inorganic) over time is important in determining sources and sinks of these inputs. Variations in contaminant input were assessed in four sediment cores taken in 1998 from three different parts of Lake Mead (two from Las Vegas Bay and one from Overton Arm and Virgin Basin). Sediments were analyzed for major and trace elements, radionuclides, and organic compounds. Anthropogenic contaminant concentrations are greatest in Las Vegas Bay reflecting inputs from the Las Vegas urban area, although concentrations are low compared to sediment quality guidelines and to other USA lakes. One exception to this pattern was higher mercury concentrations in the Virgin Basin core. The Virgin Basin core is in the main body of the reservoir and is influenced by the hydrology of the Colorado River, which changed after completion of Glen Canyon Dam. Major- and trace-elements in the core show pronounced shifts in the early 1960s and, in many cases, gradually return to concentrations more typical of pre-1960s
by the 1980s and 1990s, after the filling of Lake Powell upstream. The Overton Arm is the sub-basin least effected by anthropogenic contaminant inputs. Cores from Las Vegas Bay taken in 2007 were analyzed for emerging contaminants and although data are still preliminary, detections of musk fragrances have been found only in the upper 10 – 15 cm of the core, indicating that these compounds either degrade with time or have only been accumulating for the past 10 – 20 years.

(C8) Tracing the Sources of Uranium in the Colorado River Basin
Sanchez, Charles1, Chesely, John1, Asmerom, Yemane2, Malmon, Daniel3 (1) University of Arizona (2) University of New Mexico (3) U.S. Geological Survey

Renewed emphasis on alternative energy sources has revived interest in uranium (U) mining on the Colorado Plateau. The Colorado River is used both as a source of drinking water and a source of irrigation water for food crops. Therefore, the potential for mine waste and runoff into the Colorado River requires an understanding of current U concentrations, sinks, and sources as a prerequisite to limiting human exposure. In 2007 and 2008 water samples were collected in the Colorado River and tributaries, from Colorado to the last diversion near the international border with Mexico. In addition, sediment samples of various ages, through the Holocene period, were collected from the Colorado River. Water samples and various extracts from the sediment samples were analyzed for U concentrations by ICP-MS and isotopic ratios of U, lead (Pb) and strontium (Sr), were determined by MC-ICP/MS as a procedure to discern sources. The U content of the Colorado River increased from <0.05 μg/L at the headwaters near Grand Lake, Colorado, to values greater than 3 μg/L after descending onto the Colorado Plateau. Water diverted for municipal use and irrigation in the lower basin had U concentrations from 3 to 5 μg/L. The isotope data (Pb, Sr, and U) are consistent with the normal weathering of U containing geomedia within the watershed and rule against major contamination from U mines. However, continued measurements should be made such that a baseline can be established before future exploration and mining activity or accidental release occurs.
Author Directory
Author Directory

Acharya, Kumud
Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119
Kumud.Acharya@dri.edu
702-862-5371

Albrecht, Brandon
BIO-WEST, Inc.
1063 West 1400 North
Logan, UT 84321
ballbrecht@bio-west.com
495-752-4202

Alvarez, David A.
U.S. Geological Survey
Columbia Environmental Research Center
4200 New Haven Road
Columbia, MO 65201
dalvarez@usgs.gov
573-441-2970

Andrew, Gretchen M.
University of Nevada, Las Vegas
Harry Reid Center for Environmental Studies
4505 S. Maryland Parkway
Las Vegas, NV 89154
andrewg3@unlv.nevada.edu
702-895-2781

Arufe, Jorge A.
U.S. Geological Survey
160 N. Stephanie Street
Henderson, NV 89074
jarufe@usgs.gov
702-564-4534

Asmerom, Yemane
University of New Mexico
Radiogenic Isotope Laboratory
200 Yale Blvd. NE
Albuquerque, NM 87131
asmerom@unm.edu
505 277-4434

Bai, Seungyun
University at Buffalo
Department of Chemistry
Buffalo, NY 14260-3000
sbaik2@buffalo.edu
716-645-6800

Baldwin, Wen
National Park Service
1 Katzenbach Road
Boulder City, NV 89005
wenbald@earthlink.net
702-373-4406

Barnes, Joseph G.
University of Nevada, Las Vegas
Public Lands Institute
4505 South Maryland Parkway
Las Vegas, NV 89154-2040
joseph.barnes@unlv.edu
702-293-8756

Beard, Mitch
EarthSoft
PO Box 1376
Concord MA 01742
mbeard@earthsoft.com

Beaver, John R.
BSA Environmental Services, Inc.
23400 Mercantile Road, Suite 8
Beachwood, OH 44122
j.beaver@bsaenv.com
216-765-0582

Beckstrand, Mark
Nevada Department of Wildlife
1557 Foothill Drive, #A110
Boulder City, NV 89005
mbeckstrand@ndow.org
702-293-8109

Blasius-Wert, Becky J.
U.S. Bureau of Reclamation
PO Box 61470 (LC-2722)
Boulder City, NV 89006
bblasius@lc.usbr.gov
702-293-8109

Blunt, Susanna M.
Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119
University of Nevada, Las Vegas
4505 Maryland Parkway
Las Vegas, NV 89154
Susanna.Blunt@dri.edu
702-862-5370

Boyd, Dustin M.
PhycoTech, Inc.
620 Broad Street, Suite 100
St. Joseph, MI 49085
dbolt@phycoTech.com
269-983-3654

Boykin, Kenneth G.
New Mexico State University
Cooperative Fish & Wildlife Research Unit
Department of Fish, Wildlife & Conservation Ecology
New Mexico State Univ., Box 30003, MSC 4901
Las Cruces, NM 88003
kboykin@nmsu.edu
575-646-6303

Bruckner, James C.
Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119
Jim.Bruckner@dri.edu
702-862-5381

Burke, Thomas A.
Bureau of Reclamation
P.O. BOX 61470
Boulder City, NV 89006-1470
tburke@lc.usbr.gov
702-293-8310

Burrell, Michael D.
Nevada Department of Wildlife
1537 Foothill #A-110
Boulder City, NV 89005
mburrell@ndow.org
702-486-6739

Caires, Annie
University of Nevada, Reno
Department of Env. Science and Policy
1000 Valley Road, MS186
Reno, NV 89512
acaires@cabnr.edu
775-784-3515

Chandra, Sudeep
University of Nevada, Reno
Department of Env. Science and Policy
1000 Valley Road, MS186
Reno, NV 89512
sudeep@cabnr.unr.edu
775-784-6221

Chesely, John
University of Arizona
Department of Geosciences
Tucson, AZ 85721
jchesley@email.arizona.edu
520-621-9639

Choate, David
National Park Service

Conrad, Paulette M.
Nevada Department of Wildlife
4747 Vegas Drive
Las Vegas, NV 89108
pconrad@ndow.org
702-486-5127

Cross, Chad
University of Nevada, Las Vegas
School of Community Health Services
4505 S. Maryland Parkway
Las Vegas, NV 89154
Chad.cross@unlv.edu
702-895-5366

Cruz, Patricia
University of Nevada, Las Vegas
Harry Reid Center for Environmental Studies
4505 S. Maryland Parkway Box 454009
Las Vegas, NV 89154-4009
cruzp@unlv.nevada.edu
702-895-1417

De Leon, Ricardo
Metropolitan Water District of Southern California
700 Moreno Ave.
La Verne, CA 91750
ricardo_deleon@mwdh2o.com
909-392-5185

Deng, Xin
Texas Tech University
Texas Cooperative Fish & Wildlife Research Unit
Lubbock, TX 79409-2120
xin.deng@ttu.edu
806-742-2851

Deuser, Curtis E.
National Park Service
Lake Mead EPMT
601 Nevada Way
Boulder City, NV 89005
curt_deuser@nps.gov
702-293-8979

Dibble, Eric
Mississippi State University
Department of Wildlife and Fisheries
Mailstop 9690
Mississippi State, MS 39762
edibble@msstate.edu
662-325-7494

Dingman, Sandee J.
National Park Service
Lake Mead National Recreation Area
601 Nevada Way
Boulder City, NV 89005
sandee_dingman@nps.gov
702-298-1070

Draugelis-Dale, Rassa O.
U.S. Geological Survey
National Wetlands Research Center
700 Cajudome Blvd.
Lafayette, LA 70506
daler@usgs.gov
337-266-8689

Drury, Douglas D.
Clark County Water Reclamation District
5857 E. Flamingo Road
Las Vegas, NV 89122
ddrury@cleanwaterteam.com
702-434-6641

Echols, Kathy R.
U.S. Geological Survey
Columbia Environmental Research Center
4200 New Haven Road
Columbia, MO 65201
kechols@usgs.gov
573-876-1838

Eckberg, Jason R.
Southern Nevada Water Authority
P.O. Box 99956
Las Vegas, NV 89193-9956
jason.eckberg@snwa.com
702-822-3389

Eilts, Bruce E.
Louisiana State University
Veterinary Clinical Sciences
1841 Vet Med Bldg
Baton Rouge, LA 70803
beilts@lsu.edu
225-578-9572

Fisher, Jen C.
Desert Research Institute
755 E Flamingo Road
Las Vegas, NV 89119
Jen.Fisher@dri.edu
702-862-5385

Fisher, Lawrence H.
U.S. Geological Survey
160 N Stephanie St.
Henderson, NV 89074
lhfisher@usgs.gov
702-564-4614

Fletcher, Dawn M.
University of Nevada, Las Vegas
Public Lands Institute
4505 South Maryland Parkway
Las Vegas, NV 89154-2040
dawn_fletcher@unlv.edu
702-293-8658

Foster, Marissa
Southern Nevada Water Authority
P.O. Box 99956
Las Vegas, NV 89193-9956

Gerstenberger, Shawn
University of Nevada, Las Vegas
School of Community Health Sciences
4505 South Maryland Parkway
Las Vegas, NV 89154
Shawn.gerstenberger@unlv.nevada.edu
702-895-1565

Goodbred, Steven L.
U.S. Geological Survey
California State University,
3020 State University Dr. East
Suite 3005
Sacramento, CA 95819
goodbred@usgs.gov
916-278-9492

Hannoun, Imad A.
Flow Science Incorporated
370 Neff Avenue, Suite R
Harrisonburg, VA 22801
hannoun@flowsience.com
540-421-2102

Hoines, Josh
National Park Service
Lake Mead National Recreation Area
601 Nevada Highway
Boulder City, NV 89005
josh_hoines@partner.nps.gov
702-293-8913

Holden, Paul B.
BIO-WEST, Inc.
**Author Directory**

1063 West 1400 North
pholden@bio-west.com
435-752-4202

**Holdren, G. Chris**
U.S. Bureau of Reclamation
P.O. Box 25007 (86-68220)
Denver, CO 80225
cholden@do.usbr.gov
303-445-2178

**Hutcheson, Joseph**
National Park Service
Lake Mead National Recreation Area
601 Nevada Highway
Boulder City, NV 89005

**Jaeger, Jef R.**
University of Nevada, Las Vegas
Public Lands Institute and
School of Life Sciences
4505 South Maryland Parkwy
Las Vegas, NV 89154-4004
jef.jaeger@unlv.edu
702-895-2463

**Jenkins, Jill A.**
U.S. Geological Survey
National Wetlands Research Center
700 Cajundome Blvd
Lafayette, LA 70506
jill.jenkins@usgs.gov
337-266-8607

**Jones-Lepp, Tammy L.**
U.S. Environmental Protection Agency
944 E. Harmon Ave.
Las Vegas, NV 89119
jones-lepp.tammy@epa.gov
702-798-2144

**Karafa, Doug**
Clean Water Coalition
150 N. Stephanie Street, Suite 130
Henderson, NV 89074
dkarafa@cleanwatercoalition.com
702-319-4433

**Kavanagh, Kristen B.**
Flow Science Incorporated
Two Penn Center, Suite 200
Philadelphia, PA 19102
kbkavanagh@flowsience.com
215-854-6445

**Kegerries, Ron B.**
BIO-WEST, Inc.
1063 West 1400 North
Logan, UT 84321
rkegerries@bio-west.com
435-752-4202

**Kirsch, Janet E.**
U.S. Bureau of Reclamation
PO Box 61470 (LC-2724)
Boulder City, NV 89006
jkirsch@lc.usbr.gov
702-293-8365

**Kramer, Joanna**
University of Nevada, Las Vegas
School of Community Health Sciences
4505 S. Maryland Parkway
Las Vegas, NV 89154
Kramer10@unlv.nevada.edu
702-895-1250

**Koronkiewicz, Thomas J.**
SWCA Environmental Consultants
114 N. San Francisco Street
Flagstaff, AZ 86001
tkoronkiewicz@swca.com
928-774-5500

**LaBounty, James F.**
Southern Nevada Water Authority
1900 East Flamingo Road, Suite 255
Las Vegas, NV 89119
Jim.Labounty@snwa.com

**Leiker, Thomas J.**
U.S. Geological Survey – retired

**Linder, Greg**
U.S. Geological Survey
BRD Columbia Environmental Research Center
5400 Tacoma Street NE
Brooks, OR 97305
linder2@usgs.gov
503-390-3916

**Link, Carolyn L.**
Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119
Carolyn.Link@dri.edu
702-372-5452

**List, E. John**
Flow Science Incorporated
238 Mathis Ferry Road
Mt. Pleasant, SC 29464
ejlist@flowsience.com
626-233-6014

**Little, Edward E.**
U.S. Geological Survey
BRD Columbia Environmental Research Center
4200 New Haven Road
Columbia, MO 65201
edward_little@usgs.gov
573-875-5399

**Loomis, Eric**
University of Nevada Las Vegas
4505 Maryland Parkway, Box 453064
Las Vegas, NV 89154-3064
emloomis@unlv.edu
702-280-6149

**MacKinnon, Angela I.**
MWH Americas, Inc
3010 W. Charleston Blvd, Suite 100
Las Vegas, NV 89102
angela.mackinnon@mwhglobal.com
702-878-8010

**McLeod, Mary Anne**
SWCA Environmental Consultants
114 N. San Francisco Street
Flagstaff, AZ 86001
mmlcled@swca.com
928-774-5500

**Malmon, Daniel**
U.S. Geological Survey
345 Middlefield Road, MS 973
Menlo Park, CA 94025
mailto:dmalmon@usgs.gov
650 329-4934

**Mawhinney, Douglas B.**
Southern Nevada Water Authority
P. O. Box 99954
Las Vegas, NV 89193-9954
doug.mawhinney@snwa.com
702-856-3634

**Moore, Bryan**
National Park Service
Lake Mead National Recreation Area
601 Nevada Highway
Boulder City, NV 89005
bryan_moore@nps.gov
702-293-8901

**Moser, Duane P.**
Desert Research Institute
755 E. Flamingo Rd
Las Vegas, NV 89119
Duane.Moser@dri.edu
702-862-5534

Need assistance? Call 702-324-3105
Mueting, Sara
University of Nevada Las Vegas
4505 Maryland Parkway, Box 453064
Las Vegas, NV 89154-3064
muetings@unlv.nevada.edu
702-895-1250

Norman, Carrie
Lake Mead National Recreation Area
601 Nevada Way
Boulder City, NV 89005
carrie_norman@nps.gov
702-293-8734

O’Farrell, Michael J.
O’Farrell Biological Consulting
7320 Heggie Avenue
Las Vegas, NV 89131
mike@mammalogist.org
702-658-5222

Orphan, Lynn
Clean Water Coalition
150 N. Stephanie Street, Suite 130
Henderson, NV 89074
LOrphan@cleanwatercoalition.com
702-319-4433

Orsak, Erik L.
U.S. Fish and Wildlife Service
Division of Environmental Quality
4701 North Torrey Pines Drive
Las Vegas NV 89130
erik_orpak@fws.gov
702-658-5222

Papelis, Lambis
Desert Research Institute
755 E. Flamingo Road
Las Vegas, NV 89119
Lambis.Papelis@dri.edu
702-862-5453

Patiño, Reynaldo
U.S. Geological Survey
Texas Cooperative Fish and Wildlife Research Unit
Texas Tech University
15th St. & Boston Ave.
Lubbock, TX 79409-2120
r.patino@usgs.gov
806-742-2851

Pollard, James E.
University of Nevada, Las Vegas
Harry Reid Center for Environmental Studies
4505 S. Maryland Parkway
Las Vegas, NV 89154
pollardj@unlv.nevada.edu
702-895-1438

Preston, Al
Flow Science Incorporated
723 East Green Street
Pasadena, CA 91101
al@flowscience.com
626-304-1134

Raskin, Morgan, E.
Student Conservation Association
37 Clover Hill Lane
Colts Neck, NJ 07722
meraskin@gmail.com
732-245-7221

Rinella, Jessie J.
National Park Service
Lake Mead National Recreation Area
601 Nevada Way
Boulder City, NV 89005
Jessie_Rinella@nps.gov
702-293-8654

Roef, Peggy
Southern Nevada Water Authority
P.O. Box 99954
Las Vegas, NV 89193
Peggy.Roef@snwa.com
702-856-5041

Rosario-Ortiz, Fernando L.
University of Colorado
Civil, Environmental and Architectural Engineering
Boulder, CO 80309
fernando.rosario@colorado.edu
303-492-7607

Rosen, Michael R.
U.S. Geological Survey
Nevada Water Science Center
2730 N. Deer Run Road
Carson City, NV 89701
mrosen@usgs.gov
775-887-7683

Ryan, Roslyn
Southern Nevada Water Authority
100 City Parkway
Las Vegas, NV 89106
roslyn.ryan@snwa.com
702-862-7431

St. Amand, Ann, L.
PhycoTech, Inc.
620 Broad St. Suite 100
St. Joseph, MI 49085
astamand@phycoTech.com
269-983-3654

Sanchez, Charles A.
University of Arizona
Yuma Agricultural Center
6425 W 8th Street
Yuma, AZ 85364
sanchez@ag.arizona.edu
928-782-3836

Schiefel, Scott
City of Las Vegas
6005 Vegas Valley Drive
Las Vegas, NV 89142
702-229-6200

Sappington, J. Mark
National Park Service
Lake Mead National Recreation Area
601 Nevada Way
Boulder City, NV 89005
mark_sappington@nps.gov
702-293-8974

Schlickeisen, Erica
Mississippi State University
Department of Wildlife and Fisheries
Mailstop 9690
Mississippi State, MS 39762
ES247@msstate.edu
662-325-3830

Seeb, Sami K.
National Park Service
Submerged Resources Center
PO Box 728
Santa Fe, NM 87504
sami_seeb@nps.gov
505-988-6787

Shanahan, Seth A.
Southern Nevada Water Authority
P.O. Box 99956
Las Vegas, NV 89193-9956
seth.shanahan@snwa.com
702-822-3314

Snyder, Shane A.
Southern Nevada Water Authority
1350 Richard Bunker Ave
Henderson, NV 89015
Author Directory

shane.snyder@snwa.com
702-856-3668

Stanford, Benjamin
Southern Nevada Water Authority
PO Box 99954
Las Vegas, NV 89193
Ben.Stanford@lvvwd.com
702-856-3509

Stevens, Vanessa L.
University of Nevada, Las Vegas
School of Public Health
4505 S. Maryland Parkway Box 454009
Las Vegas, NV 89154-4009
vstevens@unlv.nevada.edu
702-895-2510

Taylor, William D.
Metropolitan Water District of Southern California
700 Moreno Ave
La Verne, CA 91750
wtaylor@mwdh2o.com
909-392-5149

Teacher, Catherine E.
BSA Environmental Services, Inc.
23400 Mercantile Road, Suite 8
Beachwood, OH 44122
c.teacher@bsaenv.com
216-765-0582

Tietjen, Ryan
National Park Service
Lake Mead National Recreation Area
EPMT
601 Nevada Way
Boulder City, NV 89005
ryan_tietjen@nps.gov
702-293-8790

Tietjen, Todd E.
Southern Nevada Water Authority
1350 Richard Bunker Ave
Henderson, NV 89015
todd.tietjen@snwa.com
702-856-5045

Trenholm, Rebecca A.
Southern Nevada Water Authority
1350 Richard Bunker Ave
Henderson, NV 89015
beck.trenholm@snwa.com
702-856-3658

Turkett, Warren B.
Southern Nevada Water Authority
1299 Burkholder Blvd.
Henderson, NV 89015
warrenturkett@hotmail.com
702-856-5048

Turner, Kent
National Park Service
Lake Mead National Recreation Area
601 Nevada Way
Boulder City, NV 89005
kent_turner@nps.gov
702-293-8941

Umek, John
University of Nevada, Reno
Department of Env. Science and Policy
1000 Valley Road, MS186
Reno, NV 89512
775-784-3515
umekj@unr.nevada.edu

Urban, Mitchell
National Park Service
Lake Mead National Recreation Area
1 Katzenbach Road
Boulder City, NV 89005
Mitchell_urban@nps.gov
702-467-3248

Van Metre, Peter C.
U.S. Geological Survey
8027 Exchange Drive
Austin, TX 78754-4733
pvanmet@usgs.gov
512-927-3506

Vanderford, Brett J.
Southern Nevada Water Authority
1350 Richard Bunker Ave
Henderson, NV 89015
brett.vanderford@snwa.com
702-856-3659

Veley, Ronald J.
U.S. Geological Survey
160 N Stephanie St
Henderson, NV 89074
rjveley@usgs.gov
702-564-4542

Weaver, Scot D.
EarthSoft
PO Box 441
Paradise, UT 84328
sweaver@earthsoft.com

Wiersma, Danielle M.
U.S. Geological Survey
160 N Stephanie St
Henderson, NV 89074
dwiersma@usgs.gov
702-564-4538

Wilson, Doyle
City of Lake Havasu
2330 McCulloch Blvd. N.
Lake Havasu City, AZ 86403
WilsonD@ilhcaz.gov
928-453-6336

Wittmann, Marion
University of California, Davis
Tahoe Center For Environmental Sciences
291 Country Club Drive
Incline Village, Nevada 89451
mwittmann@ucdavis.edu
805-448-8259

Wong, David
University of Nevada Las Vegas
4505 Maryland Parkway, Box 453064
Las Vegas, NV 89154-3064
david.wong@unlv.edu
702-895-2446

Zeigler-Holady, Janie C.
Southern Nevada Water Authority
1350 Richard Bunker Ave
Henderson, NV 89015
janie.zeigler@snwa.com
702-856-3662

Zhou, Xiaoping
Southern Nevada Water Authority
100 City Parkway
Las Vegas, NV 89106
xiaoping.zhou@snwa.com
702-822-3302
Parking has been reserved for symposium registrants on floors 5 or 6 of the parking garage. Please display the e-mailed parking permit. Electric cart shuttle service between the Artemus W. Ham Concert Hall Box Office (blue star) and the UNLV Student Union will run during the mornings and evenings of both days of the symposium. Those walking to campus from hotels on Swenson St., may wish to use UNLV’s free shuttle bus, “The Ride,” which runs every 8-10 minutes; Harmon Ave. stops are indicated with blue dots. VIP Parking has been reserved in Lot V.
The Lake Mead Science Symposium is part of a larger National Park Service, Lake Mead National Recreation Area-led initiative funded in part by the Southern Nevada Public Land Management Act.

Project Partners

Clean Water Coalition
Nevada Department of Wildlife
Southern Nevada Water Authority
UNLV Harry Reid Center for Environmental Studies
UNLV Public Lands Institute
UNLV School of Community Health Sciences
U.S. Bureau of Reclamation
U.S. Fish & Wildlife Service
U.S. Geological Survey

The Lake Mead Science Symposium was planned by UNLV’s Public Lands Institute on behalf of and in cooperation with the National Park Service, Lake Mead National Recreation Area.

Special thanks are owed to:
Dr. Allison Brody, UNLV-PLI • Wilisha Daniels, UNLV-PLI • Nancy Flagg, UNLV • Megan Iudice, UNLV-PLI • Tori Klein, UNLV • Dr. Rod Metcalf, UNLV
Peggy Roefer, SNWA • LaNelda Rolley, UNLV-PLI • Daphne Sewing, UNLV-PLI • Cathy Willey, UNLV-PLI
UNLV Athletics: Football and Women’s Basketball • UNLV Geoscience Department • UNLV Parking and Transportation Services
and all of our symposium volunteers
Welcome

Lake Mead, the largest reservoir by volume in the United States, provides diverse recreational opportunities annually for more than 8 million visitors; habitat for numerous wildlife species including several threatened and endangered species; and drinking water for more than 20 million people in Southern Nevada, Southern California, and portions of Arizona as well as water for agricultural use. Of great concern are the challenges and issues such as drought and the introduction of invasive species currently facing Lake Mead and Lake Mohave, which is also part of Lake Mead National Recreation Area. Numerous research and monitoring efforts have been conducted, are ongoing, or are in the planning stages for Lakes Mead and Mohave. We invite you to join us at this state-of-the-science symposium to share information and help synthesize these efforts.

Program

The conference program includes a plenary session featuring keynote addresses by renowned aquatic scientist James F. LaBounty, Ph.D. (Southern Nevada Water Authority), Lower Colorado Deputy Regional Director Terrance “Terry” Fulp, Ph.D. (US Bureau of Reclamation), and Executive Director Alan O’Neill (Outside Las Vegas Foundation).

Conference sessions will provide insight to assist with lake management and the development of an overall ecological monitoring strategy for the lakes. Sessions include:

- Lake Management
- Limnology and Water Quality
- Aquatic Biota and Fisheries
- Riparian and Shoreline Resources
- Contaminants
- Emerging Issues

Details about each session are available on our Web site, www.lakemeadsymposium.org. Selected session papers will be published in a special issue of Lake and Reservoir Management. Session topics are subject to change based upon abstracts received.

Symposium Partners

Participating agencies include the partners within the Southern Nevada Public Land Management Act funded initiative “Assessment of Limnological and Aquatic Resources of Lakes Mead and Mohave.” These organizations are the National Park Service, Bureau of Reclamation, US Fish and Wildlife Service, US Geological Survey, Nevada Department of Wildlife, Southern Nevada Water Authority, Clean Water Coalition, and the University of Nevada, Las Vegas. Planning for the Lake Mead Science Symposium is funded by the Southern Nevada Public Land Management Act and administered by the UNLV Public Lands Institute on behalf of the National Park Service.

Interested in submitting an abstract? Don’t delay – abstract submission deadline is October 14, 2008. Guidelines are available at www.lakemeadsymposium.org
Please complete registration for each individual in your group.

Contact Information

<table>
<thead>
<tr>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>title / position</td>
</tr>
<tr>
<td>organization</td>
</tr>
<tr>
<td>mailing address</td>
</tr>
<tr>
<td>telephone</td>
</tr>
<tr>
<td>e-mail</td>
</tr>
</tbody>
</table>

FOUR EASY WAYS TO REGISTER: ONLINE, PHONE, FAX, or MAIL

1) **ONLINE** visit www.lakemeadsymposium.org or go to http://edoutreach.unlv.edu and search "Lake Mead Science Symposium" under Course Search.

2) **PHONE** Call 702/895-3394 M-F 8:00 am to 5:00 pm. Please have your completed registration worksheet and credit card available.

3) **FAX** Transmit this two-page registration worksheet to 702/895-4195 and be sure to include credit card number, expiration date, verification number, and signature in the space below.

4) **MAIL** Enclose a copy of your purchase order or check payable to BOARD OF REGENTS. Mail the completed, two-page registration form to:

**University of Nevada, Las Vegas, Educational Outreach**
Box 451019, 4505 S. Maryland Parkway
Las Vegas, NV 89154-1019

Please charge my credit card:  □ Visa  □ MasterCard  □ Discover  □ American Express

<table>
<thead>
<tr>
<th>Card Number</th>
<th>Exp. Date mm/yy</th>
<th>Verification No.</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The card verification number on VISA, Discover and MasterCard charge card follows the card number written on the signature strip on the back of the card. On American Express cards, the number is on the front of the card.
Scholarships

A limited number of work scholarships covering the cost of registration are available for students who wish to attend the Lake Mead Science Symposium. Please contact Jennell Miller at jennell.miller@unlv.edu or call 702/895-5429 for details.

Registration

The full registration fee covers all program activities beginning Tuesday morning and extending through Wednesday afternoon. This fee includes parking, conference materials, sessions, hosted breaks and meals, and the no-host cocktails and hors d’oeuvres reception.

- Early Bird Registration (by December 19, 2008) @ $174.95 $________________
- Registration (after December 19, 2008) @ $199.95 $________________
- Registration (at the door) @ $249.95 $________________

Daily Registration Fee

A flat daily registration of $125 is available for anyone who will not be able to attend the entire symposium, including guests and presenters. The daily fee includes parking, conference materials, sessions, and hosted breaks and meals. Tuesday’s registration also includes the no-host cocktails and hors d’oeuvres reception.

- Tuesday, January 13, 2009 @ $125 $________________
- Wednesday, January 14, 2009 @ $125 $________________

Total Amount Due $________________

Refunds

Please note: Refunds, less a $35 processing fee, will be made to those registrants who cancel on or before December 20, 2008. No refunds will be made after this date, although substitutions are always accepted. The University of Nevada, Las Vegas reserves the right to cancel this program due to unforeseen circumstances and limits its liability to registration refunds only.

Questions

Contact Rochelle Boyd at rochelle.boyd@unlv.edu or call 702/895-5486 with questions about registration.

Interested in submitting an abstract? Don’t delay – abstract submission deadline is October 14, 2008
Guidelines are available at www.lakemeadsymposium.org
The Lake Mead Science Symposium provides the opportunity for researchers to share information, exchange ideas, and synthesize efforts on the ecological health of Lakes Mead and Mohave. It is a state-of-the-science event to begin to develop an overall ecological monitoring strategy for the lakes. This inaugural event was created through a unique partnership among federal, state, university, and public organizations. The Lake Mead Science Symposium is expected to attract 200-300+ attendees, including lake management specialists, scientists, researchers, students and others involved in the management of these important bodies of water. An exhibit is a great way to provide exposure for your business or company. We also invite you to consider sponsorship; levels are available that include exhibit space along with other great benefits!

**Company Information:**

<table>
<thead>
<tr>
<th>Company</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Address</td>
</tr>
<tr>
<td>City</td>
<td>City</td>
</tr>
<tr>
<td>State</td>
<td>State</td>
</tr>
<tr>
<td>Zip</td>
<td>Zip</td>
</tr>
<tr>
<td>Fax</td>
<td>Fax</td>
</tr>
<tr>
<td>e-mail</td>
<td>e-mail</td>
</tr>
<tr>
<td>Web</td>
<td>Web</td>
</tr>
</tbody>
</table>

**Contact Information:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Address</td>
</tr>
<tr>
<td>City</td>
<td>City</td>
</tr>
<tr>
<td>State</td>
<td>State</td>
</tr>
<tr>
<td>Zip</td>
<td>Zip</td>
</tr>
<tr>
<td>Fax</td>
<td>Fax</td>
</tr>
<tr>
<td>e-mail</td>
<td>e-mail</td>
</tr>
<tr>
<td>Web</td>
<td>Web</td>
</tr>
</tbody>
</table>

Please describe your company's products/services in 50 words or less.

Payment for Exhibitor Space

Please make checks payable to the UNLV Board of Regents and designate *Public Lands Institute/Lake Mead Symposium* on the check stub or memo.

Mail or hand deliver your check and signed form to:
Public Lands Institute  
Attn: Rochelle Boyd  
University of Nevada, Las Vegas  
RAJ 280, Box 452040  
4505 S. Maryland Parkway  
Las Vegas, NV 89154-2040

Conference Registration

One registration is included. Please be sure to register additional members of your group.

Early Bird Registration (by 12/13/08) = $174.95  
Standard Registration = $199.95  
Registration at the door = $249.95  
Daily Registration = $125

Registration information is available online at:  
www.lakemeadsymposium.org
About your Space

Exhibitor spaces are available on a first come, first served basis at a rate of $800. The fee includes registration for one person, a 10’ x 10’ exhibit space, two 5’ tables, table linen, two chairs, and pipe and drape.

- Additional fees apply for extra chairs, special electronics needs, and/or other requests.
- Nothing may be attached to walls of the exhibition space; grommet banners may be attached to pipe (S-hooks provided).
- Non-university organizations selling merchandise or services must provide a copy of their Federal Tax ID Number, Business License, and a certificate of insurance as required by Section V of the Student Affairs Facilities, Scheduling & Conferences General Reservation Policy.
- The exhibit space is shared with conference oral and poster sessions. Therefore, set up times are strictly limited as follows:
  - January 12 (3:30 pm to 6:00 pm) or
  - January 13 (7:00 am to 7:30 am or 11:45 am to 12:15 pm)
- No refunds will be made for missed set-up times.
- Load In/Load Out is scheduled by appointment and must be confirmed; all materials must be removed by 6:30 pm on January 14.

Tentative Room Layout -- Subject to Change Based Upon Registration Numbers

Exhibit space is indicated with blue letters in the diagram (left). First choice in space preference will be given to the primary sponsor. All other exhibitors may select spaces on a first come, first serve basis. Layout shown is subject to change based on number of registrants.

Please enter your preferences:

1st Choice  
2nd Choice  
3rd Choice  

Authorization AND Agreement

Signature

Printed Name

Date
The Lake Mead Science Symposium provides the opportunity for researchers to share information, exchange ideas, and synthesize efforts on the ecological health of Lakes Mead and Mohave. It is a state-of-the-science event to begin to develop an overall ecological monitoring strategy for the lakes. This inaugural event was created through a unique partnership among federal, state, university, and public organizations. The Lake Mead Science Symposium is expected to attract 200-300+ attendees.

In an effort to enhance our understanding of these valuable bodies of water, we are seeking sponsors who would like to support research, education, and stewardship for our shared public lands. Sponsorship is a great way to provide exposure for your business or company.

The Public Lands Institute can customize a plan to further promote and market your organization or to accommodate a budget. Please ask about customizing a package. Please provide us with your ideas to uniquely contribute to this event! Partial and shared sponsorships are also available. Also available are exhibitor spaces for rent; call for pricing.

Primary Sponsor ................................................................. $7,500
- Company name/logo prominently displayed on/near the registration table
- Inclusion of company information and permission to include a giveaway with participant materials
- Inclusion of company name/logo and link on symposium Web site
- Inclusion of company name/logo and link on the donor page of the UNLV-PLI Web site for one year
- Company name/logo listed in the program booklet as Sponsor
- Optional use of two exhibitor spaces
- Optional copy of the resulting special issue of Lake and Reservoir Management
- Optional full registration for 6 individuals

Reception Sponsor ............................................................. $5,000
- Five minutes of presentation/speaking time during beginning of reception
- Company name/logo prominently displayed on/near food service tables
- Company name/logo prominently displayed in the poster session area
- Inclusion of company name/logo and link on symposium Web site
- Company name/logo listed in the program booklet as Sponsor
- Optional use of one exhibitor space
- Optional copy of the resulting special issue of Lake and Reservoir Management
- Optional full registration for 4 individuals

Lunch Sponsor ................................................................. $4,000
- Company name/logo prominently displayed on/near food service tables during the sponsored lunch
- Recognition on a slide in the session rooms during lunch
- Inclusion of company name/logo and link on symposium Web site
- Inclusion of company name/logo listed in the program booklet as Sponsor
- Optional use of one exhibitor space
- Optional copy of the resulting special issue of Lake and Reservoir Management
- Optional full registration for 4 individuals

Please contact us by 10-20-2008. Call 702/895-5486
**Breakfast Sponsor** ..................................................................................................................................... $3,000

- Company name/logo prominently displayed on/near food service tables during the sponsored breakfast
- Inclusion of company name/logo and link on symposium Web site
- Inclusion of company name/logo listed in the program booklet as Sponsor
- Optional use of one exhibitor space
- Optional copy of the resulting special issue of *Lake and Reservoir Management*
- Optional full registration for 3 individuals

**Coffee Break** .............................................................................................................................................. $2,000

- Company name/logo prominently displayed on/near food service tables during the sponsored break
- Inclusion of company name/logo and link on symposium Web site
- Inclusion of company name/logo listed in the program booklet as Sponsor
- Space for company brochure on the Sponsor table
- Optional copy of the resulting special issue of *Lake and Reservoir Management*
- Optional full registration for 2 individuals

**Session Sponsor** ........................................................................................................................................ $1,500

- Company name/logo prominently displayed during the sponsored session
- Recognition on the title slide at the start/end of session and during break
- Inclusion of company name/logo and link on symposium Web site
- Inclusion of company name/logo listed in the program booklet as Sponsor
- Space for company brochure on the sponsor table
- Optional copy of the resulting special issue of *Lake and Reservoir Management*
- Optional full registration for 2 individuals

Please make checks payable to the **UNLV Foundation** and mail or hand deliver directly to the address below.

**Designate Public Lands Institute/Lake Mead Symposium** on the check stub or memo.

Public Lands Institute
Attn: Rochelle Boyd
University of Nevada, Las Vegas
RAJ 280, Box 452040
4505 S. Maryland Parkway
Las Vegas, NV 89154-2040

Thank you in advance for supporting this important event. You will receive a receipt for your donation from the UNLV Foundation. Please note that under current Federal Tax Law, a portion of your gift may qualify as a deductible contribution. Internal Revenue Service guidelines state that the value of goods and services provided in connection with this sponsorship is non-deductible. Please call us if you have questions.

Please let us know by 10-20-2008 of your intent to sponsor. Call Rochelle Boyd at 702/895-5486

Participating agencies include the partners within the Southern Nevada Public Land Management Act funded initiative titled, “Assessment of Limnological and Aquatic Resources of Lakes Mead and Mohave.” These organizations include the National Park Service, Bureau of Reclamation, US Fish and Wildlife Service, US Geological Survey, Nevada Department of Wildlife, Southern Nevada Water Authority, Clean Water Coalition, and the University of Nevada, Las Vegas.

Planning for the Lake Mead Science Symposium is funded by the Southern Nevada Public Land Management Act and administered by the UNLV Public Lands Institute on behalf of the National Park Service.
Save the Date!

What  Lake Mead Science Symposium

When  January 13-14, 2009

Where  University of Nevada, Las Vegas; Las Vegas, Nevada

Why  To explore the ecological health of Lakes Mead and Mohave

Lake Mead, the largest reservoir by volume in the United States, provides diverse recreational opportunities for local residents and tourists from all over the world; habitat for numerous wildlife species including several threatened and endangered species; and drinking water for millions of people in Southern Nevada, Southern California, and portions of Arizona as well as water for agricultural use. Of great concern are the challenges and issues such as drought and the introduction of invasive species currently facing Lake Mead and Lake Mohave, which is also part of Lake Mead National Recreation Area.

Numerous research and monitoring efforts have been conducted, are ongoing, or are in the planning stages for Lakes Mead and Mohave. We invite you to join us at this state-of-the-science symposium to share information and help synthesize these efforts.

Planned Conference Sessions

- Lake Management
- Limnology and Water Quality
- Aquatic Biota and Fisheries
- Riparian and Shoreline Resources
- Contaminants
- Emerging Issues

Selected papers will be considered for publication in a special issue of *Lake and Reservoir Management*. Additionally, sessions will provide insight to assist with lake management and the development of an overall ecological monitoring strategy for the lakes.

More to come: Watch for the Call for Abstracts!


Planning for the Lake Mead Science Symposium is funded by the Southern Nevada Public Land Management Act and administered by the UNLV Public Lands Institute on behalf of the National Park Service.

If you received this message as a "Forward" and would like to join our e-mail list, please contact Jennell Miller at: jennell.miller@unlv.edu