Lake Mead Ecosystem Monitoring Workgroup

Date: May 23, 2013
Location: SNWA, Molasky Corporate Center
Suite 700, Colorado River Room #1
100 City Parkway, Las Vegas NV 89106

Participants

Jason Eckberg (SNWA), ***Ron Kegerries** (BIO-WEST), ***Janet Kirsch** (Reclamation), **Dana La Rance** (Henderson), **Jennell M. Miller** (UNLV), **Erika Moonin** (SNWA), **Bryan Moore** (NPS), **Michael Moran** (USGS), **Al Preston** (Flow Science, Inc.), **Peggy Roefer** (SNWA), ***Michael Rosen** (USGS), **Roslyn Ryan** (SNWA), **Scott Schiefer** (Las Vegas), **Seth Shanahan** (SNWA), **Todd Tietjen** (SNWA), **Warren Turkett** (Colorado River Commission of Nevada), **Ashlie Watters** (NPS), and **Xiaoping Zhou** (SNWA).
* via conference call.

Action Items

- Next meeting: **July 25, 2013 • 1:00 pm • SNWA Molasky Corporate Center**
- Peggy Roefer invites group members to serve on the planning sub-committee for the next Lake Mead Science Symposium; please contact Peggy to join the committee.
- With staff changes and reassignments, group members are asked to inquire whether other representatives from their agencies/organizations would like to attend LaMEM Workgroup meetings. Please contact Peggy Roefer to add names to the e-mail list.

Summary

1. Welcome and Introductions (Committee)

Peggy Roefer opened the meeting and participants introduced themselves.

2. Workgroup Business and Updates

a. Sampling on Lake Mohave (Roslyn Ryan, SNWA)

Since January 2013, SNWA and the NPS have been sampling from five locations on Lake Mohave spanning from Hoover Dam to Katherine Landing. Lake Havasu is seeing a tremendous impact from aquatic plant growth. This assessment will provide background information to determine if there is anything entering Lake Mohave between Willow Beach and Davis Dam that could be causing the increased growth of aquatic plant life in Lake Havasu. Field parameters are measured and samples are collected for nutrients, zooplankton, phytoplankton, and chlorophyll. To date, sampling has been going well with no surprising results.

b. <u>Lake Mead Update (Todd Tietjen, SNWA)</u>
Lake Mead is starting to stratify slowly: the thermocline begins to form at some locations and breaks down by the next sample date. Based on visual inspection, zooplankton appear to being doing well this year with many large-bodied *Daphnia* observed.

c. <u>Lake Mead Observation; week of May 13, 2013 (Janet Kirsch, Bureau of Reclamation)</u>
In May 2009, following a decline in water level, a black band of quagga mussels was noted around the lake particularly on the north aspect of rocks. The 2009 band extended to 5-feet high in some locations. The black band has again returned, but to a much lesser extent than previously, and it only appears to be present in Gregg Basin and near Hoover Dam. Its maximum height is roughly 2-feet and appears less dense than the 2009 band. It is not observed in the Narrows. Possibly, quagga mussels are benefiting from a nutrient in Gregg Basin that is lacking in the Narrows (and other areas).

Question: Todd, have you been through the Narrows recently, and if so, did you observe the black line there?

Response: We went through the Narrows to Overton this week and I didn't see any evidence of it anywhere we went.

3. **SNWA Third Intake Update** (Erika Moonin, SNWA)

See Presentation File: Moonin_LaMEM_2013-05-23.pdf

Background: The addition of Intake No. 3 to Lake Mead is a major project that has been underway since May 2005 following its approval by the SNWA Board of Directors. Construction value of the project is approximately $650 million.

Lake Mead has substantially declined due to the drought experienced by the Colorado River System over the last 12 years. In response, the primary objective the new intake is to preserve SNWA's existing capacity to supply water if lake levels fall below an elevation of 1,050 feet, the elevation at which Intake No. 1 is lost. Secondary objectives are to improve water quality and increase system reliability and operational flexibility when combined with existing facilities: Intake No. 1 (low lift), which supplies the Alfred Merritt Smith Water Treatment Facility and Intake No. 2 (high lift), which supplies the River Mountain Water Treatment Facility.

Status of major milestones:

- June 2012 – The connection between Intake No. 2 and No. 3 was completed.
- March 2012 – The intake structure for Intake No. 3 was completed and placed.
- May 2013 – Underground blasting was completed.

- Current – Tunneling is underway and is 13.7 % complete
- Final project completion is anticipated for 2014; however, with delays, this target may be extended.

Connection to Intake No. 2: This aspect of the project created a 2,578-foot-long, horseshoe-configuration tunnel between the future Intake No. 3 and the existing Intake No. 2. Intake No. 2 was dewatered during the process. Quagga mussels were observed (.25 to .5-inch deep) on every surface that contacts water. The observation was surprising because the tunnel is 1,600 feet from the inlet, where the food supply would likely be diminished. The opportunity was used to power wash the tunnel and remove the quagga mussels. A chemical feed system is in place now preventing future attachment.

Intake Structure Placement: The 96-foot-high, 16-foot-diameter riser was prefabricated on shore, conveyed out to the intake location by barge, lowered into a pre-excavated hole, and anchored with 14,000 cy of concrete prepared on site at a temporary batch plant. 41,000 cy of rock and soil were removed from the intake location. This portion of the project took place between February and March 2012.

The Tunneling Process: A 30-foot interior diameter, 600-foot-deep access shaft was completed and excavated. The tunnel boring machine (TBM) produced by Herrenknecht A.G. (Germany) was assembled within a chamber at the bottom of the shaft. The fully assembled TBM is 600-feet long, weighs 856.5 tons, and is designed to operate under high water pressures. As the TBM advances, the tunnel is encased in rings of pre-fabricated concrete segments that are bolted and grouted in place to support the excavation and prevent water infiltration during construction. The tunnel will have a finished internal diameter of 20 feet and will be 14,904-feet long. To date, 13.7 % of the tunneling is complete: 162 feet with 27 rings of concrete segments installed. During the highest production day so far, 48 feet were excavated with 8 concrete segments installed.

After an expected two years of tunneling, the TBM will intersect the intake riser structure at the bottom of the lake. The TBM must precisely hit the receiving chamber of the intake riser. Once the connection is successfully made and sealed watertight, the TBM will be disassembled and removed from the tunnel. Then the intake and tunnel can be opened to the lake and fully flooded, ready for service.

Overall Project Challenges and Delays:

- The existence of variable geology throughout the project area, ranging from hard rock to weak/fractured rock. Tunneling through fractured rock necessitated additional geologic analysis and shifting the original path of the tunnel.
- High water pressures (maximum potential = 17 bar).
- Intake riser connection was extremely challenging (but it is completed).
- Intake riser connection will also be extremely challenging.

Please view the accompanying presentation PDF for project photos, maps, and additional engineering details.

4. **Climate Change Modeling In Lake Mead** (Al Preston, Flow Science, Inc.)

See Presentation File: Preston_LaMEM_2013-05-23.pdf

Background: Flow Science, Inc. and the Southern Nevada Water Authority worked together to model potential changes in Lake Mead limnology under climate change. The Lake Mead Model, based upon the three-dimensional ELCOM and CAEDYM simulation codes, was used for the study. The Lake Mead Model was previously calibrated for the years 2000-2008 and comparisons with field data were made at more than 20 locations. Parameters included: temperature, salinity, bromide, and perchlorate along with algae (chl-a), TOC, phosphorus, nitrogen, DO, and pH.

Project: Climate change has been predicted to impact Lake Mead directly and indirectly. Changes in air temperature directly impact surface water temperature. Indirect impacts include changes that occur in the upstream Colorado River such as alterations in water temperature, volumes, and timing of flows. The Lake Mead Model was used to conduct an evaluation of a variety of these different conditions that might be observed in the future. Air temperatures were adjusted to reflect median predictions for the 2050s and 2090s as well as the 90th percentile for the 2090s. Ten model simulations were completed. Primary drivers were air temperature and inflow water temperature. Air temperatures were selected using climate change projections from the Coupled Model Intercomparison Project, Phase 3 (CMIP3).

Results Overview: In general these manipulations resulted in increases in lake temperatures and loss of water through evaporation. The model output also suggested increased thermal stratification. Dissolved oxygen concentrations in the hypolimnion were predicted to decrease. A "Hoover Dam" effect was discussed where the withdrawals from the epilimnion were shown to alter water quality in Boulder Basin. Lower water surface elevations would result in higher concentrations of suspended solids throughout the lake, while at the location of SNWA Intake No. 3 higher water temperatures, bromide, and TOC concentrations could be observed.

Algal biomass was strongly influenced under the 2090s 90th percentile scenario and moderately influenced by the 2090s median scenario. With warmer temperatures, there was a shift in the spring chlorophyll peak to earlier in the year and values through the summer months that were below those of recent years. The summer minimum extended later than under current conditions and lead to a slightly larger fall peak in chlorophyll concentrations. Annual averages remained approximately the same. However, concentrations could increase due to lower water surface elevation and due to lower Colorado River inflow rate. Under climate change conditions, it is possible that a shift in algal species will be observed. These results suggest that the impacts of climate change on Lake Mead will produce incremental shifts in existing patterns that, while relatively small, have the potential to alter the operation of the lake.

The following entities were acknowledged: Bureau of Reclamation, Southern Nevada Water Authority, and member agencies of the Clean Water Coalition.

5. **Restoration of the Las Vegas Wash** (Jason Eckberg, SNWA)

See Presentation File: Eckberg_LaMEM_2013-05-23.pdf

Background: Since 2000, the Las Vegas Wash revegetation program has been underway to develop ecologically functioning wetland, riparian, and upland areas surrounding the Las Vegas Wash. Its purpose is to improve the ecosystem to a self-sustaining state, which is the vision established by the Las Vegas Wash Coordination Committee for this program. The effort also fulfills permit requirements for stormwater discharge and for the construction of erosion control structures. Furthermore, erosion control structures have been funded by multiple grants, which, likewise, required revegetation components. Prior to the implementation of this project, tamarisk (salt cedar) was a dominant issue for the Las Vegas Wash. In 2001, approximately 1,500 acres of tamarisk lined the Wash channel. Much of the tamarisk has been removed as part of the construction of erosion control structures and in property development; and, only 142 acres remain today.

Project: Extensive planning was undertaken to ensure that the revegetation effort was successful. To maximize the likelihood that plants could become self-sustaining, a careful investigation examined soil types and conditions as well as depth to water. Resulting data were mapped so that appropriate native plants could best matched to the many microclimate conditions surrounding the Wash. Choosing the right plants has been key to the success of the program.

Each revegetation sub-project (on-going) is scheduled to occur following construction activities. Between 2001 and 2012, 360 acres have been revegetated. Of these, 178 acres were planted by volunteers who have participated in 22 semi-annual "Green Up" events (with an average of 600 participants per event). Planting involves potted nursery plants, seeding, and pole planting and transplants. Cottonwood, willow, arrowweed, and seepwillow are planted as pole plants. Pole planting of these species has been much more cost effective and successful than using potted plants. Bulrush and saltgrass removed from the construction sites have been successfully transplanted. Irrigation is required in the two growing seasons following revegetation. The project has used spray and drip irrigation methods with water pumped from the Wash using mobile pumps.

Results Overview: Revegetated sites are monitored using a cover-class system to describe cover, invasive species cover, and species richness; line-intercepts are used to assess survivorship. Also monitored are wildlife usage and site changes. Average site cover across all revegetation sites has increased from less than 40 percent to more than 80 percent since year 1 of planting. Average survivorship increases in the growing seasons following planting, with a year-1 survivorship of 72 percent. Invasive species cover has fluctuated over the years; its highest percentage was 6.1 percent and was 2.5 percent in 2012. Species richness also varies. As of 2012, 267 plants have been identified along the Wash.

6. **Selenium in the Las Vegas Wash and its Urban Tributaries** (Xiaoping Zhou, SNWA)

See Presentation File: Zhou_LaMEM_2013-05-23.pdf

Background: Due to its tendency to bioaccumulate in aquatic ecosystems, Southern Nevada Water Authority (SNWA) has regularly monitored selenium in Las Vegas Wash water. This monitoring program has been ongoing since 2002, providing more than 10 years of data. The Environmental Protection Agency (EPA) is in the process of updating the acute and chronic freshwater ambient water-quality criteria for selenium to reflect the latest scientific information. However, the standard values currently in effect are as follows: freshwater acute ≤ 20 µg/L and freshwater chronic ≤ 5 µg/L.

Between 2002 and 2013, ten sites were monitored along the mainstream Las Vegas Wash including a background site and a site at Lake Las Vegas. LW10.75 is the most upstream site (composed completely of urban runoff), which serves as the background site. The yearly average selenium concentration at LW10.75 has typically been found to be between 12 and 14 µg/L. LW6.05 is the site that occurs after the wastewater treatment plant; between 2003 and 2013, the yearly average selenium concentrations at LW6.06 and each subsequent downstream site were dramatically lower at less than 4 µg/L. These results showed that the high selenium concentrations entering the Wash from urban tributaries are greatly diluted by wastewater effluent. In 2007, new monitoring sites were added to the existing selenium monitoring program. In particular, two sites were added after the wastewater treatment plant at locations occurring before and after the Monson Channel. It was noted that selenium concentrations were slightly higher at the sampling site downstream of Monson Channel compared to the post-wastewater treatment site. Initial tributary monitoring revealed that all urban tributaries were found to have selenium concentrations that were relatively elevated. The highest concentrations were found in Monson Channel (20-22 µg/L) and Duck Creek (18-22 µg/L).

Project: To locate selenium sources (hot spots) within the tributaries to Las Vegas Wash, a tributary monitoring program was initiated. During an investigation conducted in 2003 and 2004, average data showed the selenium hotspot to be the Whitney Drainage of Duck Creek. To further narrow the location of the Duck Creek hot spot and any others that might exist, an intensive tributary monitoring program was conducted between 2011 and 2013. Monitoring occurred quarterly with one sample taken every half mile along with samples from dewatering pipes. Samples were analyzed for selenium by a San Diego State University laboratory.

Results Overview: The intensive monitoring program confirmed the Whitney Drainage as the selenium hotspot with Whitney Mesa being the likely source. The Whitney Drainage concentrations ranged between 34 and 62 µg/L between 2003 and 2009, with concentrations decreasing since 2009. The second heaviest selenium contributor was the Monson Channel with concentrations ranging between 20 to 25 µg/L during the study period. Results of mass loading calculations show that the Wash contributes 1,400 to 1,700 lbs/year of selenium to Lake Mead. The tributaries contribute 36 to 77% of the load to Las Vegas Wash, and Duck Creek, in particular, contributes 29 to 49% of the tributary total.

Question: What selenium species do you have?

Response: SNWA Two studies have been done to address speciation. The first was a single-day study with samples analyzed at SNWA. The second speciation study occurred over the course of a year. For both studies, analyses were performed for selenite, selenate, and total. All results showed selenate to be the dominant species, with selenite almost non-detectable.

Question: Do you analyze bird eggs and tissue?

Response: Yes. Results from this study (at least three years of data) can be found in the annual Bioassessment Reports. Please speak to Seth Shanahan (SNWA) for more information about this work.

7. **The Impact of the Grand Canyon High Flow Experiment on Lake Mead** (Todd Tietjen, SNWA)

See Presentation File: Tietjen_LaMEM_2013-05-23.pdf

Background: Maintenance of sandbars in the Colorado River ecosystem is a goal of the Glen Canyon Dam Adaptive Management Program. Sandbars not only provide critical habitat to the endangered humpback chub, they also provide sandy beaches used for camping and other recreation. The objective of the Grand Canyon/Glen Canyon High Flow Experiment (HFE) is to try and rebuild sandbars by moving sand accumulated in the riverbed to the shoreline. HFEs have been conducted twice in the past, demonstrating some success in building beaches. Unfortunately the built beaches do not last and so authorization was sought to repeat the events as resources allow. This presentation provides an overview of SNWA-led water quality studies at Lake Mead associated with an HFE implemented in November 2012.

Prior to the event, daily release fluctuations are reduced to allow sand to build up. After this period, the typical high flow discharge pattern is as shown below (which was also used for the November 2012 HFE). The water passes through both the hydroelectric plant and the bypass tunnels.

- Rapid ramp-up of the flow (~12-hour period)
- Sustained high discharge (~24-hour period)

- Initial, gradual decrease in flow (~72-hour period)
- Rapid decline and return to normal daily fluctuations (~10-hour period)

The November 2012 flow event lasted for approximately four days at Lees Ferry and 5.5 days at Diamond Creek. It takes the flood about 2.5 days to reach Diamond Creek.

Project: More high flow events are expected in the future. The purpose of this project was to identify changes in water quality resulting from the November 2012 HFE to provide an idea of what could be expected in terms of water quality when these future events are conducted. The water quality sampling (from the Colorado River to CR360.7) was a coordinated effort by SNWA, the City of Las Vegas, and NPS-LMNRA with support from the USGS monitoring platform. The lake was sampled four times at a variety of locations in upper Lake Mead: two locations near the mouth where the Colorado River comes in and other locations downstream. Baseline sampling was conducted just before the event.

Post-flood Water Quality Analysis Results:

Specific Conductance – The only immediately available measure of water quality for the water leaving Lake Powell was specific conductance, a measure comparable to salinity. The HFE resulted in an increase of ~65 µS/cm at the peak of the release, tapering off as the flood release was reduced. While the HFE water increased the conductivity of the water at Lees Ferry (Glen Canyon tends to accumulate salty water at its low elevations), even the peak values observed were lower than those typically measured in Lake Mead. This produced in Lake Mead a Colorado River plume of lower conductivity water (relative to Lake Mead) that was similar to the normal inflow. The plume occurred as an interflow rather than an underflow, which would be preferred.

Temperature – The temperature of water at Lees Ferry was only .5 degree lower than normal (a very slight drop). The water entered cool at 13/14 C as interflow.

Dissolved Oxygen (as percent saturation) – The HFE water was well oxygenated and this oxygen was carried with the Colorado River interflow plume. This result would have little impact on Lake Mead water quality as the upper water column likely would be well oxygenated during mixing of the water column. If the HFE plume were to follow the bottom of the lake, the inflow could help re-oxygenate the bottom waters of the lake during years with incomplete mixing. This process is already observed during the summer months when the Colorado River water can supplement the oxygen concentrations in the bottom of Boulder Basin.

If an event was conducted in such a way that interflows were sustained for weeks, some effects might be observed further downstream with oxygen not being introduced at the bottom.

Turbidity – Only one turbidity measurement could be made during the project; more data are needed for this parameter. Relatively high turbidity was detected at the Colorado River confluence.

From a water quality standpoint, water-treatment operations are suited for low turbidity water. If a plume extended further into the lake at an interflow level (the elevation of the intakes), concerns could arise from the perspective of water treatment.

Management Implications and Recommendations: A variety of scenarios (i.e., different release patterns) have been proposed for conducting the HFE events. Therefore, the magnitude of impact from future HFEs is hard to predict. If inflow had extended all the way into Boulder Basin, it probably would have entered at intake depth, again, where increases in turbidity would be of concern. If, under another scenario, the Colorado River water entered as a warm overflow, sediments would definitely be carried further downstream into the lake; whether they would reach Boulder Basin and the intakes is unknown. Lake Powell can accumulate high conductivity/salinity waters in the bottom of the lake depending on upstream inflow and mixing dynamics. The temperature and conductivity of the water used in the HFE (future events) plays an important role in determining the location of the plume in the Lake Mead water column. Knowing more about the water quality that is likely to be released would be beneficial in gauging potential impacts to Lake Mead or in modeling impacts of potential HFEs.

It was also noted that the conditions during which the November HFE was conducted were particularly cold and windy; under other circumstances (e.g., a milder winter) insertion of an warm interflow (with intermediate temperatures relative to the water column) could reinforce stratification of the water column. The lake destratifies every other year on average. If the hypothetical event occurred following a non-destratification year, it would extend the duration of low oxygen conditions at the bottom, most certainly creating an impact. This would depend on a number of factors.

A shortcoming of the 2012 HFE (from the Lake Mead water quality perspective) was the low level of monitoring that could be conducted. Recommendations for future events include:

a) Provide advance warning of the event date to allow SNWA to coordinate assistance from partners
b) Conduct the event on a non-holiday weekend to ensure enough monitoring staff are present.

SNWA is working to develop a sampling plan using the 2012 event as a template. The sampling plan will detail what SNWA would like to monitor, and where and how often data will be collected. SNWA would then work with other lake stakeholders to best collect this data based on the schedule of the HFE. Expanding communications would help predict the “destination” of the HFE water. This would require inputs from Lake Powell and Grand Canyon managers. The project needs to improve the reliability and quality of the turbidity data. This is essential data and we are already working on it. It would be helpful to identify an additional tracer to more precisely track the HFE inflow. Specific conductance is useful but verifying our measurements with a more precise tracer would be beneficial.

8. Lake Mead Science Symposium

Planning is underway for the 2014 Lake Mead Symposium in cooperation with the Nevada Water Resources Association. The broader conference is tentatively scheduled for February 24-27, 2014; with the Lake Mead Symposium taking place on Tuesday, February 25. Peggy invited LaMEM Workgroup participants to serve on the planning committee. Volunteers were: Kumud Acharya, Chris Holdren, Jennell Miller, Michael Rosen, Todd Tietjen, Kent Turner, Ashlie Watters, and Xiaping Zhou. Any other individuals interested should contact Peggy.