LAKE MEAD ECOSYSTEM MONITORING WORKGROUP

Date: December 5, 2012
Location: SNWA, Molasky Corporate Center
Suite 700, Colorado River Room #2
100 City Parkway, Las Vegas NV 89106

ACTION ITEM

- Next meeting: February 21, 2013 at 1:00 pm. Molasky Corporate Center, Colorado River Room 2.

SUMMARY

1. Welcome and Introductions

2. Workgroup Business and Brief Updates

    a. LaMEM Chair Position – Discuss/Decide – Peggy Roefer was elected Chair

    b. Bacterial/Algal Sampling on Lake Mohave (Todd Tietjen) – The NPS and SNWA will be conducting a joint sampling on Lake Mohave beginning in January 2013. Five locations will be sampled on a monthly basis for one year.

    c. A Synthesis of Aquatic Science for Management of Lakes Mead and Mohave, USGS Circular Report Update (Michael Rosen)

The circular has been completed. The cover was shown to the audience and the document should be online sometime in the spring. Copies will be available and can be requested from USGS. Michael gave a special thanks to Jennell Miller for her assistance in completing the document.

    d. Glen Canyon Dam EIS Update (Seth Shanahan)

Alternative development is underway on the Glen Canyon Dam EIS.

3. Topic Presentations

    a. Bureau of Reclamation Lake Mead Water Quality Monitoring (Chris Holdren, Reclamation)

Lake Mead has the greatest capacity of any reservoir in the United States and second only to Lake Powell in surface area. Lake Mead is one of the first multipurpose reservoirs constructed by the federal government. Water from Lake Mead is used as a source of supply for 25 million municipal and industrial water users, for agriculture, for power generation, and for recreation. It is unlikely that the southwest could have been developed without the water and power provided by Lake Mead.

The Reclamation monitoring program started in 1990. Samples were collected at 14 sites in the Boulder Basin along a transect from the Las Vegas Wash inlet to the Hoover Dam. Profile data (temperature, dissolved oxygen, pH, and conductivity), secchi depth, chlorophyll a, phytoplankton, and zooplankton were analyzed at each location. In 1991, nutrients were added and the sampling was shifted to monthly. In 1998, perchlorate and bacteria were added. A standardized system of nomenclature was adopted by all agencies in 1999. In 2000, standardized methods were adopted for nutrient analysis. Sampling of Lake Mead was expanded in 1999 to include 5 sites from the Virgin River to the Overton Marina. Six sampling locations were added to the monitoring program in 2001 from the mouth of the Grand Canyon to the Narrows above Boulder Basin along the mainstem of the Colorado River. During 2007-2012 there were 24 sites monitored throughout the lake.

Lake Mead surface elevation increased during the 1980's and late 1990's due to increased rainfall. During the early 1990's and 2000's drought caused the elevation to decline. The Colorado River is the largest inflow into Lake Mead, accounting for 96.2% of the water. Hoover Dam discharges account for 83% of the water leaving the lake. SNWA withdrawals 5.1% of the water in Lake Mead and evaporation accounts for another 11.9% of the loss.

Temperature affects the chemical and physical processes in the lake. During warmer months lakes stratify into distinct layers based on temperature and density. The epilimnion is the upper warmer layer of water that is in contact with the surface. The hypolimnion is the lowest layer of water which is cool and heavy. The metalimnion or thermocline is the layer between the epilimnion and hypolimnion, which prevents mixing. During colder months when there is no stratification the water is free to mix. The temperature and density of the inflow determines how the water enters the lake. If the inflowing water is warm, the water will enter as an overflow. If the inflowing water is cold and dense the water will travel as an underflow. This inflow of water can carry higher bacteria, nutrients, and turbidity.

The primary nutrients of concern to lake managers are nitrogen and phosphorus. These nutrients are necessary for the growth of aquatic plants and animals. In Lake Mead, the limiting nutrient is phosphorus. Significant reductions in phosphorus concentrations in wastewater discharges to Lake Mead have been made since 2001. Orthophosphate entering the lake via the Las Vegas Wash was lower from 2005-2010 than seen in previous years. In 2011, the orthophosphate concentrations entering Lake Mead through Las Vegas Wash were the highest they have been since 2004. This may be related to the

North Las Vegas treatment plant coming online, but it is too early to tell for sure if that was the cause of the increased phosphorus concentrations.

Ammonium perchlorate, a component of rocket fuel, was manufactured in Henderson from approximately 1945 through 1988. Perchlorate entered the environment through disposal of wastes into unlined ponds and other leaking components at the facilities. In July 1997, perchlorate was discovered in Southern California water supplies and eventually traced to the Las Vegas Wash. Remedial efforts have been very successful. In 1998, perchlorate concentrations entering Lake Mead were near 800 ug/L. Perchlorate concentrations entering Lake Mead have been 50 ug/L or less since 2009.

Adult quagga mussels were discovered in the Boulder Basin in January 2007. The larval mussels (veligers) had spread to all sampling stations by May 2008. Significant impacts on water quality, lake biology and infrastructure are expected. To date, no significant impacts on water quality or lake biota have been published that can be directly attributed to quagga Mussels.

Lake Mead is arguably the most important reservoir in the United States. The ecology of Lake Mead is influenced by the temperature and content of the inflows, and by the position at which they enter the water column. Phosphorus is the limiting nutrient affecting algal growth (chlorophyll a), Secchi depth, and potentially the spread of quagga mussels.

b. Lake Mead Treadfin Shad Monitoring (Debora Herndon, NDOW)

Hoover Dam was completed in 1935, creating Lake Mead. Largemouth bass and sunfish were stocked and Lake Mead became known for as a prime black bass fishery. During the 1940’s, the fishery began to decline with bass in poor condition. A study of the fishery determined that there was a lack of cover and forage for the bass. Starting in 1954, threadfin shad were stocked in Lake Mead. Threadfin shad are small in size, prolific, pelagic, and are not competitive with sport fish. Threadfin shad became well established and the largemouth bass condition improved. In 1963, Lake Powell began filling and Lake Mead elevation dropped. The elevation patterns in Lake Mead changed to declines in the spring and rising elevations in the fall/winter. This affected the largemouth bass spawning in the spring. Harvests of largemouth bass declined during this time.

Striped bass were stocked in Lake Mead starting in 1969 to improve the fishery. Striped bass flourished on the large biomass of threadfin shad. By the late 1970’s, striped bass had depleted the threadfin shad numbers. The threadfin shad population fluctuates from year to year and follows a boom/bust cycle. Threadfin shad provide forage for all sport fish and are the main forage for striped bass.

In the 1980s UNLV conducted a Lake Mead Fertilization Project. The objective of this project was to increase shad production from the bottom up through the application of fertilizer to the lake. Shad trawls and monitoring began at the locations that received fertilizer.

Shad trawls are normally conducted with a 1 meter diameter mesh net that is towed for 10 minutes in the evening hours. Larval shad are around 6-22 mm total length. Captured shad are preserved in alcohol and are counted and reported as the number of shad/ 100 cubic meters. The average of 4 -5 weeks of sampling is used to calculate the values. There are 5 monitoring stations in the Overton Arm and 3 stations in the Boulder Basin.

Graphs of yearly shad production show 2-3 years of low productivity followed by a peak in shad numbers. In 2012 there was poor production for Las Vegas Bay and Boulder Basin. The Overton Arm has had three years of poor production, so a peak is likely in the spring. Stations further from to the Las Vegas Wash have historically had the lowest shad production. Threadfin shad are very important to the striped bass fishery. Poor threadfin shad numbers normally translate into poor striped bass conditions.

c. Peregrine Falcons as Bio-monitors: Assessing Mercury in the Environment (Joseph R. Barnes, UNLV)

The first breeding pair of peregrine falcons was discovered at the Lake Mead National Recreational Area in 1985. In 2006, park-wide searching and mapping of potential habitat began along with a prey-base assessments. The number of known occupied territories in the park has increased dramatically in the past three decades, from 1 in 1985 to 38 by 2012. Substantial increases in the number of territories since 2006 are likely attributed to increased monitoring efforts and new survey techniques. Survey efforts in 2011 and 2012 have been reduced to a subset of the total known territories, but occupancy at these sites remains over 90%.

Mercury was assessed in peregrine falcons by analyzing feathers from falcons and associated prey species. During monitoring efforts, falcons were banded to assess mortality and site turnover. Mercury bioaccumulates in aquatic systems in the form of methylmercury. Mercury exposure in humans can cause neurological disorders. In birds, mercury exposure can negatively affect nervous, circulatory, and endocrine systems. Previous studies suggest that mercury concentrations in feathers correlate with reduced reproductive success in several bird species. Peregrine falcons are an ideal biomonitor for mercury because they are a high trophic level predator with broad dietary breadth. Peregrine falcons also have long lifespans, with strong site fidelity, and have a wide geographical distribution. Feather analysis is beneficial to other methods because it is relatively non-invasive. Mercury is deposited in feathers during feather growth. There is a high correlation between dietary intake, total body burden, and mercury concentration in feathers.

Samples from 11 peregrine falcon territories within the park and 6 from other locations in southern Nevada were used to determine mercury levels. One hundred and one feathers were tested from forty peregrine falcons. Analyses of 308 prey items from 89 species were also conducted. The mean mercury concentration of peregrine falcons sites outside of the park in southern Nevada was 2.6 ppm in adults and 0.6 ppm in nestlings. Mercury concentration in the park area was 12.9 ppm in adults and 4.5 ppm in nestlings. Some peregrine falcons in the park had values greater than 30 ppm of mercury. The analysis of the prey species showed that aquatic birds had over six times higher concentrations of mercury than terrestrial birds. Aquatic birds account for over three times the diet of falcons in the park compared to falcons outside the park. An eared grebe, an aquatic bird, was the most contaminated prey species with an average mercury concentration of 12.7 ppm.

Levels of mercury in local peregrine falcons are high enough to possibly negatively impact reproduction and survival, and may have broader ecological implications. Breeding adults at four of eleven territories had greater than 15 ppm mercury. Mercury levels in peregrine falcons are comparable to populations of common loons, osprey, and bald eagles in several contaminated areas. Additional research is needed to assess productivity, mortality and turnover of peregrine falcons around Lake Mead, and to assess the total extent of mercury contamination after this baseline study.

d. Shoreline Vegetation (Alice Newton, NPS and E. Cayenne Engel, UNLV)

The decrease in elevation in Lake Mead has exposed soil that was once covered with water. This modification could change desert soil properties, primary succession, and cause invasive species problems and barren land. A study was conducted to assess how drawdown in the lake has been altering vegetation succession and soil properties. Ten transects were established at Boulder Beach, Stewart's Point, and in the Overton Arm. Five plots in each transect were representative of five elevations. Plant species at each location were collected and Tamarisk were counted. Soil samples were collected and analyzed.

The soil properties at Boulder Beach and Overton had similar sandy textures and there was no pattern from year to year. Total species richness increase was site specific. Perennial species richness were not as numerous as the control sites. Native plant colonization was greatest on oldest surfaces. Tamarisk declined with increased surface age. There were no strong differences in soil properties among surfaces. *Arctomecon californica* was observed in 13 year old formerly submerged plots. The EC correlated with salt concentration and was highest at young sites except for Stewarts Point. Soil texture did not differ among surfaces and submersion exposure resulted in no changes. Variation among sites suggests parent materials have more influence on soil than submersion. Plant species composition is showing patterns of increasing native species through time.

Observed early colonization of both annual and perennial species concurs with the general principle that both plant groups are represented in both early and late-successional desert communities. Many of the colonizing perennial species (cheesebush, sweetbush, and wirelettuce) also inhabit washes in non-anthropogenically disturbed ecosystems. Washes are periodically disturbed, and species inhabiting them colonize a variety of other disturbed environments, including the Lake Mead shoreline. *Ambrosia dumosa* (bursage or burro bush) was both an early colonizer and an inhabitant of the never-submerged community, consistent with the principle that deserts contain "versatile" species found throughout successional sequences. Exclusive late-successional species such as *Larrea tridentata* (creosote) remained sparse after 13 years of surface exposure, consistent with the principle that establishment of late successional communities requires longer periods of time.

Fluctuating lake levels will make revegetation efforts more difficult. Management should focus on revegetation of early successional species instead of late successional species. Selective Tamarisk removal should be included in revegetation efforts

e. Bacterial Monitoring in High Use Coves (Craig Palmer, UNLV)

Surface water monitoring in high use sites in the Lake Mead National Recreational Area was conducted between 2003 -2011 to evaluate the quantities of indicator bacteria present. The study included 10 high use areas within the Lake Mead National Recreation Area. Sampling was conducted in May through September to correlate with high use months. Sampling was conducted twice a month and after holidays. Each sample was collected 20-30 feet from the shoreline about .5 meters below the surface. The SNWA microbiology lab analyzed the samples. Water temperature, air temperature, boats, visitors, vehicles, and weather data were collected.

The results showed *Escherichia coli* exceeded the water quality standards in 4 of 655 (0.6%) samples collected. Enterococci exceeded the standards in 30 of 496 (6.0%) samples. Fecal Streptococci exceeded the standards in 34 of 649 (5.2%) samples and fecal coliforms exceeded the standards in 20 of 655 (3%) samples.

Factors that can potentially increase bacterial indicators are visitations, water temperature, and wind. The mean temperature of the samples where the bacterial counts exceeded the water quality standards was 28.1 ˚C. Wind data from the USGS weather stations located on the lake at the water quality monitoring stations in Boulder Basin (near Sentinel Island) and in the Virgin Basin were used to evaluate wind velocity and direction 24 hours prior to sampling. Wind velocities and directions were compared between exceeded and non-exceeded samples. Among all measurements, there is no difference in maximum wind speed between exceeding events and non-exceeding events (T-test, df=682, $P = 0.238$).

Evaluation of fecal coliforms count vs. maximum wind speed, a positive correlation was only found in Boulder Beach ($P = 0.042$), with no correlation found in other locations ($P > 0.05$). For fecal coliform count vs. wind direction, no correlation was found in any location ($P > 0.05$). There was a significant correlation between bacteria count and wind speed for the north facing areas ($P = 0.031$) while no correlation for other facing areas ($P > 0.05$). Significant correlation between bacteria count and wind direction was found at north facing (0.031) areas, but not in other facing areas ($P > 0.05$).

For *E. coli* count vs. maximum wind speed, positive correlation was only found in Hemingway ($P = 0.035$), with no correlation found in other locations ($P > 0.05$). For *E. coli* count vs. wind direction, correlation was found in Placer Cove ($P=0.008$), but there was no correlation in other locations ($P > 0.05$). There was a significant correlation between bacteria count and wind speed for the north facing areas ($P = 0.014$) while no correlation for other facing areas. Significant correlation between bacteria count and wind direction was found at east facing ($P = 0.038$) or north facing (0.023) areas, but not in other facing areas ($P > 0.05$).

For fecal coliforms count vs. maximum wind speed, positive correlation was only found in Boulder Beach ($P = 0.042$), with no correlation found in other locations ($P > 0.05$). For fecal coliform count vs. wind direction, no correlation was found in any location ($P > 0.05$). There was a significant correlation between bacteria count and wind speed for the north facing areas ($P = 0.031$) while no correlation for other facing areas ($P > 0.05$). Significant correlation between bacteria count and wind direction was found at north facing (0.031) area, but not in other facing areas ($P > 0.05$).

For fecal Streptococci count vs. maximum wind speed, positive correlation was only found in Boxcar Cove ($P = 0.045$), with no correlation found in other locations ($P > 0.05$). For fecal Streptococci count vs. wind direction, correlation was found at Placer Cove ($P = 0.008$), but not in other locations ($P > 0.05$). There was a significant correlation between bacteria count and wind speed for the south facing areas ($P = 0.042$), while no correlation for other facing areas ($P > 0.05$). Significant correlation between bacteria count and wind direction was found at east facing (0.030) areas, but not in other facing areas ($P > 0.05$).

Surface water monitoring of high use areas has identified problem locations and should be continued. Some high use coves (Placer Cove) are particularly at risk. An education program for the public on the hazards of purposeful introduction of fecal waste into the lake or shoreline is recommended.

f. Lake Mead Science Symposium

Another Symposium is planned during the NWRA conference on February 24 to 27, 2014. the Tuscany Casino during the NWWA meeting, similar to last time. There may not be enough new information so a one day event will probably be planned. More information will be available soon.

4. Announcements, reminder of next meeting date, assignments, and close.

The next meeting will be held on February 21, 2013.