

Statement of Work
Limnological and Riparian Resource Condition Assessment for
Lake Mead National Recreation Area (LAKE)

Funding Opportunity Announcement: P14AS00042

1. Introduction and Overview

This Statement of Work (SOW) pertains to a Limnological and Riparian Resource Condition Assessment (LRCA) in and adjacent to Lake Mead National Recreation Area (LAKE, Figure 1). The LRCA will complement the park's Natural Resource Condition Assessment in which upland resources were addressed, and will provide an evaluation of current ecological conditions and discernible trends for limnological and riparian resources and ecosystem processes, identify critical data and knowledge gaps, and highlight existing and potential threats to limnological and riparian resources and ecosystems within the park. This assessment will rely on existing scientific data from multiple sources, as well as the best professional judgment of an interdisciplinary team of specialists, to evaluate current status and suggest future conditions for limnological and riparian resources in the park.

The assessment will focus on a subset of limnological and riparian resources and processes selected by the park for particular attention. A list of topics and themes that will be addressed by this LRCA are provided in Table 2.

LRCA Background

Beginning in Fiscal Year 2003, the NPS Water Resources Division received an increase in base funding to assess watershed-scale natural resource conditions within NPS park units. The division's Natural Resource Condition Assessment Program (NRCA) is overseeing these assessments. As a result of input from NPS staff at parks and regional and national level offices, a determination was made to fund a comparable condition assessment for each of the 270-plus parks that have significant natural resources and related values. LAKE is currently involved in a project to assess the condition of the park's upland natural resources in a joint study with other parks in the Mojave Network Inventory and Monitoring Program (MOJN). This project is a separate study that will assess the condition of the park's limnological and riparian resources. The assessment will be titled "Limnological and Riparian Resource Condition Assessment for Lake Mead National Recreation Area."

The Superintendent and resource managers at the park are the primary audience for the LRCA. It is anticipated that NPS managers will use the LRCA products, findings and conclusions to support:

- near-term strategic planning, such as prioritizing limited staff and budget allocations for natural resource protection and restoration;
- Resource Stewardship Strategy and State of the Park development;
- justifications for natural resources conservation project proposals;
- park efforts to communicate and partner with other stakeholders to address landscape scale resource management issues and educational outreach; and
- public information on park resources for website and social media and for NPS Centennial documents

Lake Mead National Recreation Area

General description of the park and important limnological and riparian resource topics are provided in Appendix A.

2. Statement of Work

Objectives

The project seeks to interpret and synthesize existing scientific information into a form that park managers can readily apply for use in park decision making and resource planning. By incorporating published research, data from the NPS Inventory and Monitoring Program, additional unpublished NPS and other agency data and information, and relevant professional expertise, the assessment will provide managers and the public with the most current determination of resource and ecosystem conditions available.

The project will result in park specific reports and spatial data that: a) describe park limnological and riparian resources in a regional context; b) provide an interdisciplinary evaluation of current resource conditions and discernible trends; c) document critical data gaps and research needs; and d) document high-priority resource management issues.

Guidelines

The standards for NRCA documents will be adhered to by this study. The NRCA standards are described in detail on the NPS NRCA website (www.nature.nps.gov/water/nrca/guidance.cfm). The core document includes five chapters:

1. LRCA Background Information
2. Introduction and Resource Setting (Limnological and Riparian)
3. Study Design and Scoping
4. Natural (Limnological and Riparian) Resource Conditions (see below)
5. Discussion

Chapter 4 - Natural (Limnological and Riparian) Resource Conditions contains the primary assessment analysis and supporting information for each topic, including:

- a. Description and Assessment Measure
- b. Data and Methods
- c. Reference Conditions/Values
- d. Resource Condition and Trend
- e. Level of Confidence
- f. Data Gaps/Research Needs
- g. Management Recommendations
- h. Source of Expertise
- i. Literature Cited

Examples of completed reports can be accessed at the NPS NRCA website
(<http://www.nature.nps.gov/water/nrca/reports.cfm>).

Other Considerations

Team Expertise - The selected Partner should assemble a team with members that have substantial expertise in the limnological and riparian resources, processes and ecosystems that are of greatest concern and importance in the park. Specifically, for the LAKE LRCA, the expertise should be particularly relevant to the primary topics described under Focal Themes and Resources (below). Expertise should also include experience and background by at least one member of the partner's team for each of the resource elements included in Table 2.

Park-specific focus - This LRCA will result in a similar set of products as for all NRCAs as outlined in this SOW. However, each assessment project must consider park-specific variables such as:

- park purpose and significant resources, resource setting, and landscape context (current and historic land-use, adjacent land-use, fragmentation, regional context)
- status of park resource stewardship planning; for example, whether a park has in place a Resource Stewardship Strategy;
- types and amounts of scientific data and information available for use in the assessment;
- other related projects or studies ongoing at the park that may require coordination or data sharing with the LRCA.

Ecological Framework - NPS will collaborate with the Partner to identify the appropriate ecological framework to be used in the LRCA as described in the Guidelines. The framework to be used will be agreed upon between the Partner and the Coordinating Committee (described below) early in the project development process and will be included in the study plan. There are a number of frameworks that can be considered, including but not limited to an Environmental Protection Agency-Science Advisory Board (EPA-SAB) framework, and the NPS Ecological Monitoring Framework. A partial list of potentially useful assessment frameworks and methodologies is provided on the NRCA program website at nature.nps.gov/water/nrca/frameworks.cfm. A review of completed NRCA projects will also provide additional examples on frameworks previously adopted.

Reference Conditions - An important part of the project involves the identification or development of appropriate reference conditions against which to assess the current status of identified resources. Reference conditions may be qualitative or quantitative based on existing data and knowledge for a given resource. An additional goal of the effort is to integrate resource condition evaluations across multiple ecosystem components, such as species, communities, and physical processes, to provide syntheses of overall ecosystem condition. Where applicable, ecosystem syntheses will be applied to relevant park areas, such as watersheds, ecosystem/habitat types, or park management zones.

Scientific Integrity - For many resources and processes, sufficient data will not exist to quantitatively assess condition. To maintain scientific credibility, available data and information will be combined with professional expertise to develop valid assessments. Additional credibility will be achieved through transparent, well-documented logic and assumptions, and by communicating a level of confidence associated with all findings and conclusions.

Spatial (GIS) Component - The report will incorporate a strong geospatial component for all topics for which spatial analysis and/or presentation will provide important additional supporting information. (For example, simple presentations of resources in formats that are readily available in existing NPS documents or from other sources may not be necessary unless they are specifically requested by the NPS.) All original spatial data and/or analyses developed by the partner will be delivered as part of the final report, and will include metadata that meets Federal Geographic Data Committee (FGDC) standards for geospatial content.

3. Methods

A project coordinating committee ('Committee') will be assembled by NPS to provide critical project collaboration between the Partner and NPS (Table 1). Additional members will be added to the committee at the discretion of the LAKE staff once the Partner is selected and prior to the first scoping meeting.

Based on this SOW, the selected Partner will:

- draft a Study and Implementation Plan that will be reviewed and approved by the NPS Committee for LAKE;

- in collaboration with NPS, determine the data and information sources most pertinent and useful to the project and compile those materials into the formats needed for project-related analyses;
- provide a multi-disciplinary synthesis of data and information describing current conditions for each topic. The final products will include a written report as well as all relevant spatial and non-spatial data, data analyses and metadata.

During the course of the project, the Partner and the Committee will communicate regularly to assure that NPS has adequate opportunities for input and review of draft products and findings. In addition, the Partner will keep NPS apprised in a timely manner of any potential deviations from the agreed-upon schedule.

Table 1. Preliminary members of the NPS project coordinating committee for the LAKE assessment. Other members may be added or substituted during the course of the project.

| Individual | NPS Affiliation | Position Title |
|-------------------|------------------------|---------------------------------------|
| Jennifer Haley | LAKE | Chief, Resource Management |
| Bryan Moore | LAKE | Branch Chief, Physical Resources |
| Kent Turner | LAKE | Water Resources Specialist |
| Mark Sappington | LAKE | Branch Chief, Data Management and GIS |

Project Phases

Phase 1 - The Partner will organize an initial scoping meeting with NPS LAKE and MOJN staff to establish specific goals and objectives for the assessment as directed by the priority resources and topics (described below). During the on-site scoping meeting and subsequent conference calls and visits, the Partner will work with NPS staff to identify existing sources of scientific data and information useful for the project, and both parties will develop a data-sharing and metadata development strategy for both spatial and non-spatial data.

Phase 2 - Based on the results of the site visits and conference calls, the Partner will develop a comprehensive Study and Implementation Plan which will incorporate the goals, objectives, and data management strategy described above. The plan will be reviewed and accepted by the Committee before work proceeds.

Phase 3 - The Partner will produce a draft written report ('LRCA') for the park in accordance with the NPS Requirements and Guidelines for NRCAs described below. (The Partner should be aware that the NRCA national guidelines are subject to change, though it will be the responsibility of the Committee to make the Partner aware of any substantial changes to the guidelines or directives during the project.) The final document will be prepared according to NPS publication directives for the Natural Resource Report series (<http://www.nature.nps.gov/publications/NRPM>). Ongoing communication between the Partner and the Committee will be maintained to assure the quality of the product, and will be the responsibility of both the Partner and NPS.

Phase 4 - Upon delivery of the final draft, NPS will manage its peer review. The Partner and NPS will work together to address and respond to reviewers' suggestions until both NPS and the Partner approve the final document.

Phase 5 - NPS will coordinate the final publication process through the NPS Natural Resource Publication program identified above.

4. Focal Themes

A list of priority limnological and riparian resource elements has been selected by park staff for inclusion in the LRCA (Table 2), and all of these topics should be addressed (i.e., included in Chapter 4). Initial meetings and conversations between the Partner and the Committee will determine the relative amount of effort to be directed to each area and may result in a prioritization of this list. Within this list, the park has highlighted four existing data sets for which trend analysis would provide additional value beyond the standard suite of elements. These include: trend of base surface water limnology in the Overton Arm, surface water temperatures, trend in base productivity (species composition and volume) of phytoplankton and zooplankton, and detected changes in base limnology since invasion by non-native quagga mussel.

5. Products

The Partner, in collaboration with the NPS, will produce the following:

1. A Study/Implementation Plan that includes:
 - a. specific objectives and scope of the project based on potential themes, individual park needs, available data, park site visits, and NPS NRCA Guidelines;
 - b. the environmental assessment framework the Partner intends to utilize;
 - c. data management strategy;
 - d. detailed implementation schedule and budget.
2. A final written report for the park in accordance with NPS publication standards (www.nature.nps.gov/publications/NRPM) that includes all of the elements described above under NRCA Guidelines. In addition, the report will include an Executive Summary (5 pages or less), References, and relevant Appendices as determined by the Partner and the Committee. (Suggested appendices include long species lists [e.g. plants], web links, data sources, relevant legislation or management directives, metadata, citations, complex maps or graphics, and expert contact information.)
3. All spatial and non-spatial data and analyses developed for the assessment, with metadata. (Existing data with metadata can be referenced, but metadata must be created in cooperation with park staff for data that are utilized but have no existing metadata.)
4. A final presentation to park staff and their invited associates.

Table 2. Potential resource elements to be addressed in the LAKE LRCA.

| Limnological and Riparian Resource Elements | Comments Regarding Desired Analyses |
|--|---|
| Water Resources | |
| <p>Surface water quality (base limnology) Surface water temperature</p> | <p>An expected analysis is the trend over the past 10 to 15 years of water temperatures, at surface and the water column. The raw temperature data is available from regional monitoring agencies, including Southern Nevada Water Authority and the Bureau of Reclamation. A management concern is that water temperatures may be warming due to climate change and lake volumetric changes due to lower lake levels. Warmer water temperatures increase potential for nuisance algae, as well as potential for human pathogens of concern to body contact recreation.</p> |
| <p>Surface water quality (contaminates)</p> | |
| <p>Surface water quality (recreation suitability)</p> | |
| <p>Ecosystem Effects from Pollutants</p> | |
| <p>Human Health Effects</p> | |
| Biological Integrity and Ecosystem Effects | |
| <p>Phytoplankton</p> | <p>An expected analysis is the trend in plankton species composition and base food web productivity. Phytoplankton and zooplankton samples have been collected and analyzed monthly for the Boulder Basin for over 20 years, and monthly at 24 lake-wide stations from 2004 – 2011. This data is available from regional agencies.</p> |
| <p>Zooplankton</p> | |
| <p>Benthic</p> | |
| <p>Invertebrates</p> | |
| <p>Invasive Species</p> | |
| <p>Forage Fish - Foodweb</p> | |
| <p>Native Fish</p> | |
| <p>Sportfish</p> | |
| <p>Birds</p> | |
| Vegetation | |
| <p>Aquatic Vegetation</p> | |

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|----------------------|
| Riparian Communities |
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Table 2. Continued.

| Limnological Riparian Resource Elements | Comments |
|---|---|
| External Influences | |
| Development and urbanization impacts | One expected outcome of this project is an assessment of condition and trends in water quality within the Overton Arm portion of Lake Mead. Basic limnological data has been collected for the Overton Arm since 2004. This data, however, has not been analyzed to provide information on the status and trends of water quality in relationship to objectives to protect fisheries, wildlife, and recreation. |
| Recreation | |
| Watershed, River and Reservoir Management | Assessment of Overton Arm, as above, will assist towards watershed assessment for Virgin and Muddy Rivers. |
| Climate Change | |
| Population and Use | |
| Development impacts | |
| Recreation | |
| Fisheries | |
| Nuisance/Invasive Species | |
| Riparian | |
| Aquatic | An expected analysis would be detected changes to date, or trends, in basic limnological parameters or food web production (plankton) since the invasion by non-native quagga mussel. |

6. Roles and Responsibilities

The Partner will:

- collaborate with NPS and other partners in identifying sources of information;
- review park, I&M network, regional, NPS-wide data sources, and other relevant data sources for each resource topic prioritized for each park (relevant data include monitoring data bases maintained by Southern Nevada Water Authority, the USGS Nevada Water Science Center, and Bureau of Reclamation Lower Colorado Region and Denver Technical Center);
- compile, assess, and summarize existing information to assess the ecological condition of priority resources;
- communicate with NPS to identify watershed, habitat and/or ecological assessment framework(s) to use in the project;
- organize and lead the conference calls or meetings identified in the SOW;
- conduct work and report findings in a manner that meets Department of the Interior policy and guidelines for integrity of scientific and scholarly activities (<http://www.doi.gov/scientificintegrity/index.cfm>);
- meet NPS publication format guidelines and standards;
- ensure all geospatial data products are in compliance with FGDC standards for geospatial content; submit geospatial products to the Committee for NPS review when the project is 75% completed;
- provide metadata in compliance with Federal Geographic Data Committee (FGDC), including the documentation of processing steps involved in creation of final GIS products (if applicable);
- assure the ability of NPS to share or distribute products both internally and with external partners, allowing for confidentiality of T&E species information and for copyrights or permissions;
- create cartographic products in a format that adheres to the National Park Service's Graphic Identity Program standards (<http://imgis.nps.gov/templates.html>).
- provide NPS all supporting data, including GIS-related coverages, metadata, documentation, reports, etc. from the project.
- clearly acknowledge NPS in any published material and presentations.

The NPS will:

- assign a Key Official and NPS Project Manager. The NPS Project Manager is the NPS point of contact for the Partner, will lead the Committee, and will coordinate between the Partner and other NPS park unit staff, the NPS Pacific West Regional Office (PWRO), and the Mojave Inventory and Monitoring Network (MOJN). The NPS Project Manager will participate in project management decisions throughout the duration of the project and serve as a liaison with Partner personnel regarding compliance with NPS resource management objectives and policies pertinent to the conduct of this project;
- participate in project development and planning, review interim and final products in a timely manner and participate in meetings as needed;
- assign, as appropriate, other NPS staff including LAKE park staff, PWRO staff, and/or NPS Water Resources Division (WRD) staff to collaborate with the Partner to provide guidance, technical assistance, and logistical coordination as needed;
- coordinate and collaborate with the Partner during information/data collection and status assessment to ensure that the synthesis is consistent with the project goals. Such collaboration may include: access to GIS data layers and information, limited GIS assistance by NPS staff, identification of key data maintained by regional agencies including Southern Nevada Water Authority, Bureau of Reclamation, and USGS, participation in the development and review of the interim and final reports;

- provide NPS source data and information where available for the subject Parks including data located in Servicewide NPS databases, relevant NPS unpublished documents, and unpublished spatial and non-spatial data located at LAKE and MOJN I&M;
- clearly identify and acknowledge Partner in all published material and presentations;
- coordinate and complete the publication process according to NPS NRR guidelines.

7. Projected Project Schedule

Table 3. Projected Timeline and Responsibilities.

| Milestone | Description | Date | Responsible |
|--|--|--|--------------------|
| Project Initiation | | September 2014 | Partner/NPS |
| Site Visit/Scoping Meeting | NPS and Partner convene to share NPS data | As soon as possible after funding, no later than Nov. 1 2014 | Partner/Committee |
| Development and Acceptance of Study Plan, including data mgmt., data sharing, and metadata | NPS and Partner discuss and agree on indicators, datasets, methodologies and data management | Feb. 1, 2015 | Partner/Committee |
| Information Collection and Review | Acquire and prepare for analysis (if necessary) all necessary data and information | March 1-June 1, 2015 | Partner |
| Assess Resources | Conduct resource assessments to develop initial findings regarding condition of resources | May 1 - Dec 31, 2015 | Partner |
| First Draft Report | Submit first draft of LRCA with Committee input as needed | Dec. 31, 2015 | Partner |
| Draft Report Review | Committee provides timely response and input | March 1, 2016 | Committee |
| Draft Report Revision | Submit final draft report for NPS peer review | June 1, 2016 | Partner |
| NPS Peer Review | NPS submits final draft report to selected peer reviewers | June 1-Oct. 1 2016 | NPS |
| Prepare Final LRCA | Incorporate peer review and NPS comments and submit Final Report | Nov. 1, 2016 | Partner |
| Present Findings | Present findings and final report to NPS | Nov. 1, 2016 | Partner |
| Final Publication | NPS publication in NRR | Jan. 31, 2017 | NPS |

8. General References

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APPENDIX A. GENERAL INFORMATION FOR LAKE MEAD NATIONAL RECREATION AREA

Established in 1964, Lake Mead NRA is the nation's first National Recreation Area, and with 1.5 million acres is among the largest units of the NPS outside of Alaska. It is located along the Colorado River in the states of Nevada and Arizona, east of Las Vegas, Nevada and west of the Grand Canyon. The primary feature of the Recreation Area is Lake Mead, formed by the Hoover Dam. The Recreation Area also contains Lake Mohave, formed by the Davis Dam, approximately 60 river miles south of the Hoover Dam. Although the reservoirs are the area's primary features, the Recreation Area contains over 1.3 million terrestrial acres. They contain outstanding examples of exposed geology, elements of three of North America's four deserts, a variety of wildlife habitats and species, and over 200,000 acres of designated wilderness. The park resides entirely within the Mojave Desert, with extreme summer temperatures and less than 4 inches annual precipitation per year.

Lakes Mead and Mohave provide significant benefits that made development of the southwestern United States possible. The lakes also provide important aquatic habitat for a variety of wildlife including endangered species, and a diversity of world-class water based recreational experiences for more than 6 million people annually. They supply critical storage of water supplies for more than 25 million people in three Western states (California, Arizona, and Nevada). Storage within Lake Mead supplies drinking water and the hydropower to provide electricity for major cities including Las Vegas, Phoenix, Los Angeles, Tucson, and San Diego, and irrigation of greater than 2.5 million acres of croplands.

Lakes Mead and Mohave together provide opportunities for millions of visitors to enjoy a wide array of water-based recreation in a spectacular desert setting. The water based recreation of the Lake Mead National Recreation Area provides over \$500,000 million annually in economic benefit to the region, and over \$45 million in direct sales for concession operations on the lakes.

Lake Mead receives over 97 percent of total inflow from the Colorado River as it exits the Grand Canyon. This source water is of an outstanding quality. Approximately one percent comes from the combined Virgin and Muddy Rivers, whose watersheds face increasing urbanization. A little over two percent comes from the Las Vegas Wash, which returns the treated wastewater from Las Vegas valley as well as urban runoff from rain events. For over 25 years, based on NDEP permit requirements, the water reclamation districts discharging into the Las Vegas Wash and the Southern Nevada Water Authority (SNWA) have maintained a network of permanent water quality monitoring stations across the Boulder Basin. From 2006 to 2011, in large part with funding from the Southern Nevada Public Lands Management Act (SNPLMA), NPS and SNWA partnered with BOR to extend monthly monitoring for 24 stations throughout the entirety of Lake Mead. In addition, NPS and SNWA partnered with USGS for 5 continuous time water quality and weather monitoring platforms throughout Lake Mead.

The wealth of existing information was enhanced in 2004 with funds to the National Park Service from the Southern Nevada Public Lands Management Act. The funding was intended to enhance the existing interagency partnerships, expand monitoring and research efforts beyond the Boulder Basin lake-wide, and to expand beyond water quality parameters to include ecological monitoring. Results from this work were presented at the 2012 Lake Mead Science Symposium, and summarized in the January 2013 U.S. Geological Survey Circular 1381, "A Synthesis of Aquatic Science for Management of Lakes Mead and Mohave."

The USGS Circular 1381 summary on water quality states that:

"water quality in Lakes Mead and Mohave generally exceeds standards set by the State of Nevada to protect water supplies for public uses: drinking water, aquatic ecosystems health,

recreation, or agricultural irrigation. In comparison to other reservoirs studied by the U.S. Environmental Protection Agency for a national lake assessment Lake Mead is well within the highest or “good” category for recreation and for aquatic health. While a small part of the lake, particularly Las Vegas Bay, is locally influenced by runoff from urbanized tributaries such as Las Vegas Wash, contaminant loading in the lake as a whole is low compared to other reservoirs in the nation which are influenced by runoff from more heavily urbanized watersheds.”

While monitoring indicates that Lakes Mead and Mohave maintain overall good water quality, a number of concerns have arisen in the past few years. Lake Mohave had noticeable algae blooms in 2011 and 2012, detected by visitor and staff reports, and confirmed as blue-green algae by follow-up monitoring. SNWA obtained a Bureau of Reclamation WaterSmart grant to use the Lake Mead ELCOM/CAEDYM water quality model to evaluate potential limnological impacts to Lake Mead at various lower lake levels, which could result from climate change or continuing drought. Preliminary information indicates that Lake Mohave could experience significant changes in water quality at low lake levels, as warmer surface water is released through the Hoover Dam.

While NPS bacterial monitoring on Lake Mohave has not indicated significant issues related to visitor use, a number of single bacterial samples in high use areas on Lake Mohave had bacteria counts above acceptable limits had they occurred across more than one sample. Warmer waters in Lake Mohave and Lake Mead due to climate change, or lowering lake levels over shallow bottom areas, increase the possibility of issues related to human pathogens.

Monitoring has documented that Lake Mead water quality responds to influences from the tributaries: the urbanized Las Vegas Wash, the Muddy and Virgin Rivers, and the Colorado River. Climate change models also indicate an increased probability for summer flash flood rainfall events. Floods from urbanized Las Vegas Valley through the Las Vegas Wash, and from urbanized and agricultural areas of the Virgin and Muddy River watersheds, have been documented to negatively influence Lake Mead water quality, with increased pathogens as well as nutrients which may sponsor algal blooms. In June 2013, for example, brown foam with noticeable fish mortality was noted for several weeks in the upper Overton Arm, near the inflow of the combined Muddy and Virgin Rivers.

Modifications to flows within the Colorado River may occur due to drought, climate change, or watershed management activities. Existing data and water quality models can track the incoming plume of Colorado River water generally as a bottom flow to the Hoover Dam. Changes in temperature of the Colorado River may alter flow patterns and limnology within Lake Mead.

Figure 1. Hydrology and vicinity map of Lakes Mead and Mohave, within Lake Mead National Recreation Area.

