

National Park Service
U.S. Department of the Interior
Lake Mead National Recreation Area



Long-term Limnological and Aquatic Resource Monitoring and Research Plan for Lakes Mead and Mohave

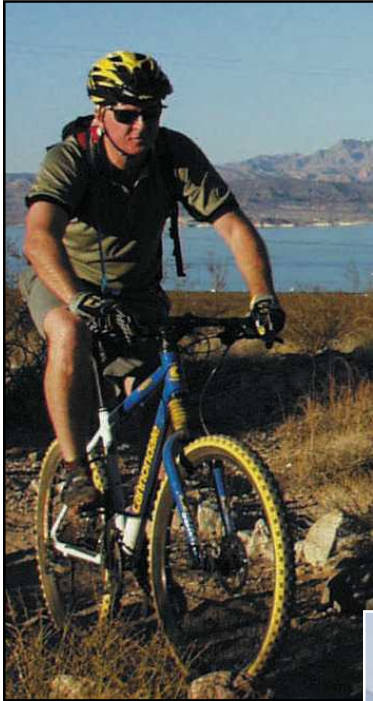
Kent Turner
May 2012



First National Recreation Area
Largest National Recreation Area
One of the most visited units of the National Park System

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Supporting a wide variety of active recreation



Responsible for protection of Natural and Cultural Resources



Lake Management



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**Important regional waterbird area,
with over 93 documented species of waterbirds
Including bald eagles and peregrine falcons**



Lakes Mead and Mohave are Critical habitat for endangered razorback sucker



Courtesy Bureau of Reclamation

Storage for drinking water for over 23 million people



Photo SNWA
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**Significant sportfishing with over 250,000
annual angler use days**



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Power Generation Infrastructure

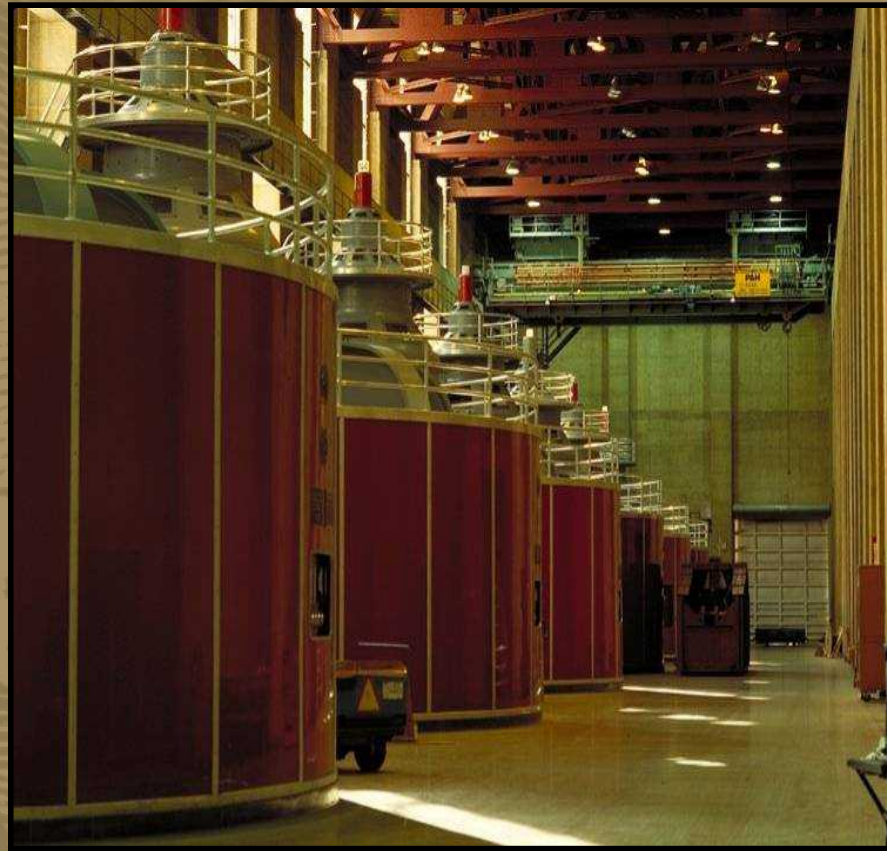


Photo USBR

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2.5 Million Acres of Irrigated Croplands



Photo USBR

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Lake Mead Characteristics

157, 418 surface acres

532 feet deep at deepest, 182 feet mean depth

Stores over 28,800,000 acre feet

Over 750 miles shoreline

4 Marinas; Over 2,800 Slipped Boats

Up to 4,000 Boats on the Water at Peak Use

Over 6,000,000 Visitors Annually (7 to 8 million for Lake Mead NRA)

97% of inflow is Colorado River water

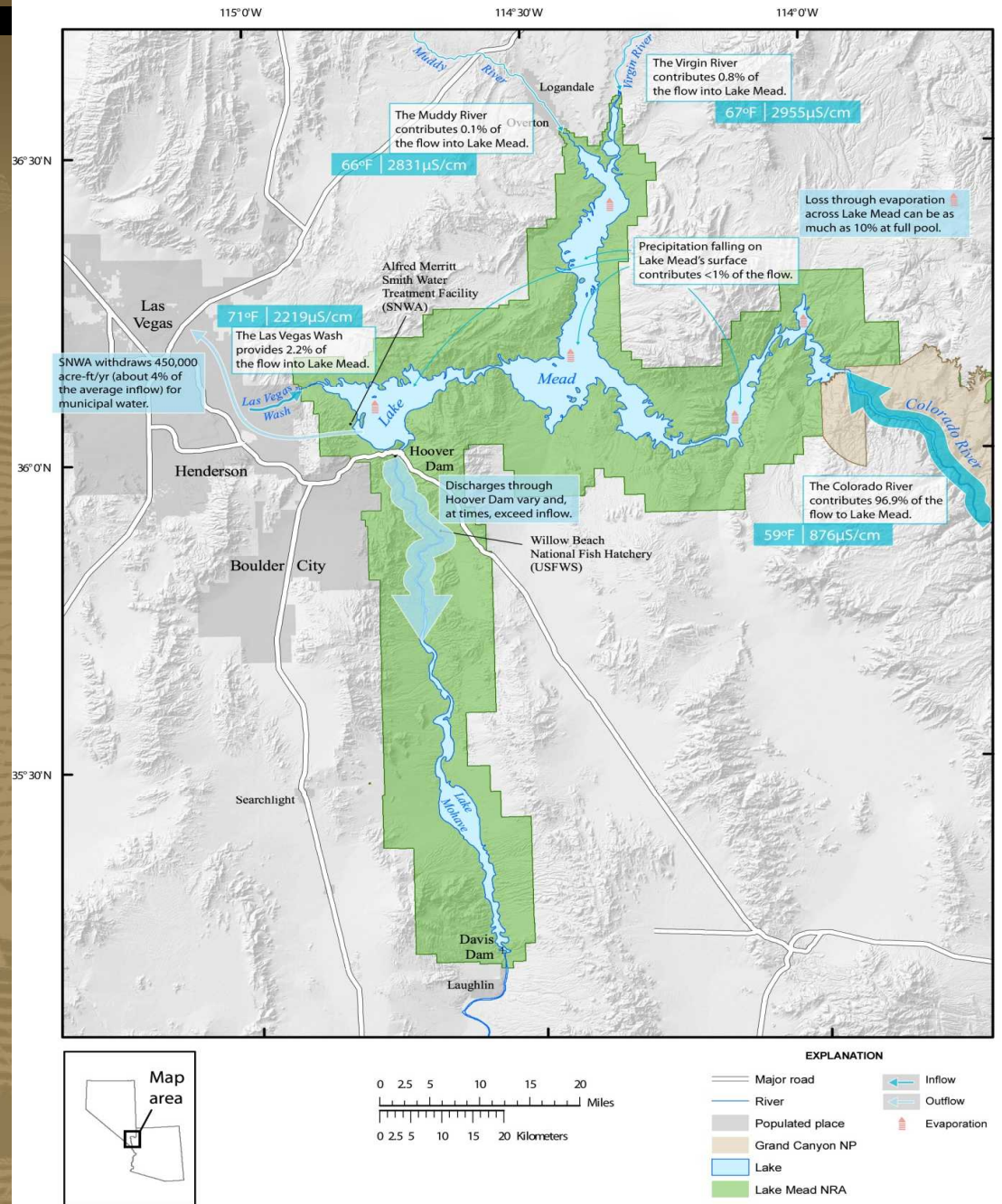
2.6 year water retention time

A key storage reservoir, fluctuates in response to snowpack

Razorback sucker unique as naturally recruiting population



Tributary Inputs and Hydrology Model –
 Colorado River 97%
 Virgin River 0.8%
 Muddy River 0.1%
 Las Vegas Wash 2.2%



Lake Mead Water Budget

Approximate annual inflow into Lake Mead (8.23 maf release from Lake Powell plus average intervening flows between Lake Powell and Lake Mead)	9.0 maf
Approximate annual outflow from Lake Mead (Lower Division State apportionments and Mexico Treaty allocation plus downstream regulation including side inflows, evapotranspiration, transmission losses, etc.)	- 9.6 maf
Approximate annual Lake Mead evaporation loss	<u>- 0.6 maf</u>
Water Balance	- 1.2 maf*

**The equivalent of about 12 feet in elevation at Lake Mead*

**Lower basin states at full utilization – as upper basin states approach full utilization, and with climate change models: Expect more dramatic and more frequent fluctuations in the future*

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Lake Mead National Recreation Area
Challenges and Stressors

Urbanization Within Tributaries

Water Quality

Tributary Inputs

Invasive Species – Quagga Mussel

Contaminants

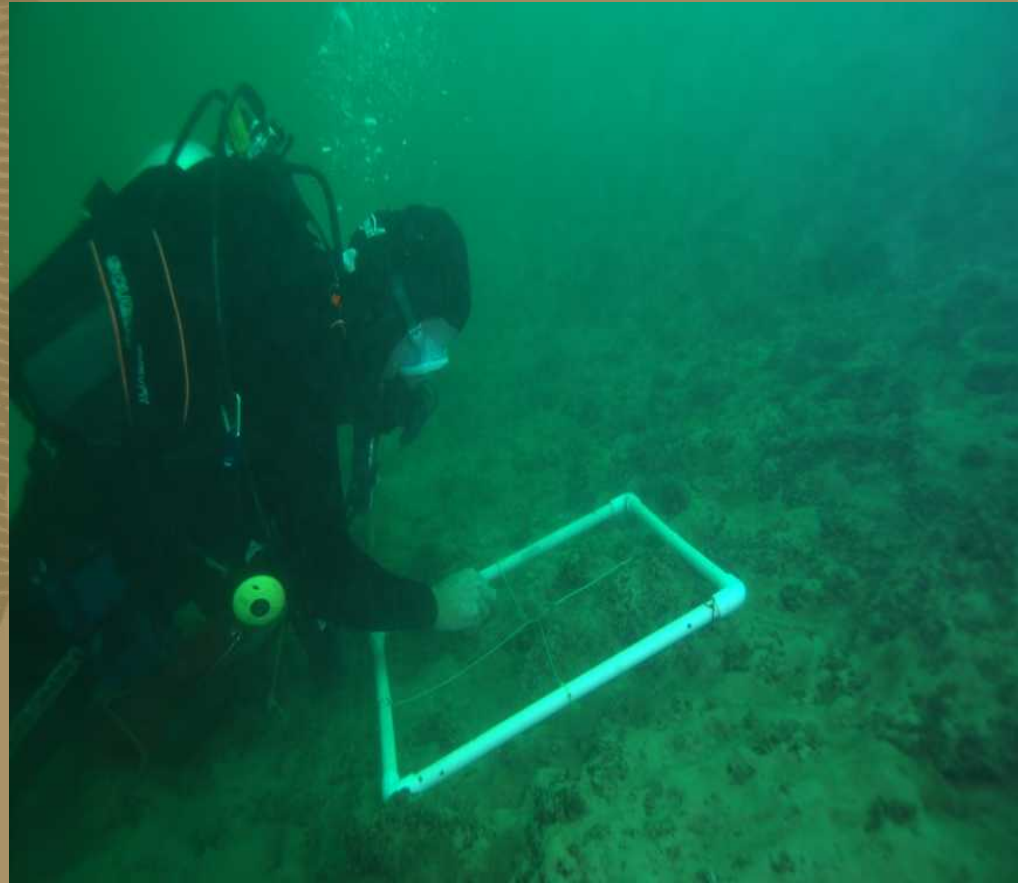
Legacy

Emerging Contaminants

Water Quantity

Climate Change, Drought

User Needs and Demands



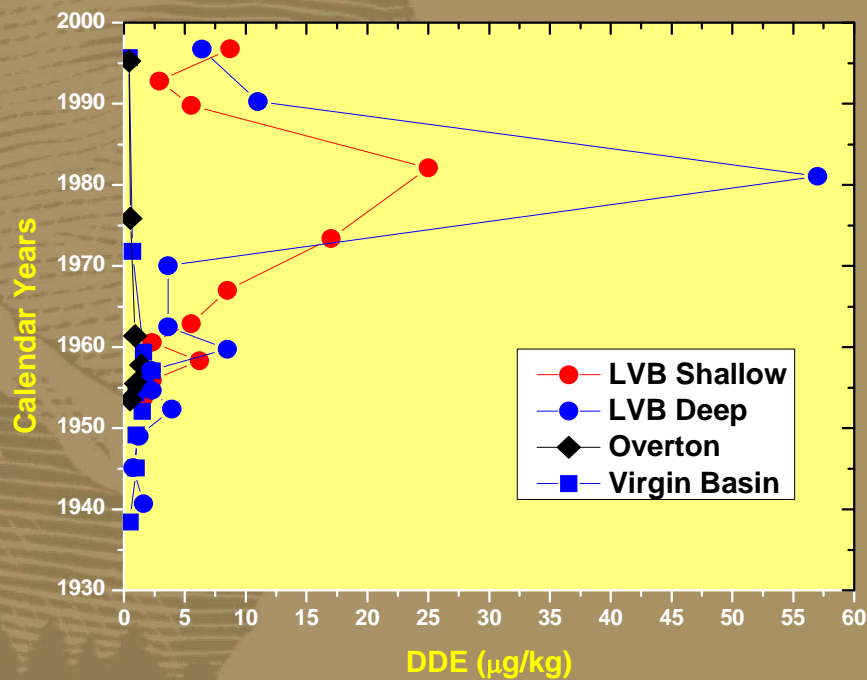
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Legacy and Regional Contaminants

More than 50 compounds detected in Las Vegas Bay

Approximately 30 compounds detected in Overton and Virgin Basin

Compounds detected: OC pesticides, PCBs, furans, dioxins, PAHs, & phenol



Graph courtesy USGS

Current Knowledge of Endocrine Disruption In Lake Mead

Studies conducted in 1995 and 1999–2000 showed that male carp from Las Vegas Bay have low blood levels of androgen and smaller testes compared to male fish from reference sites.

The same studies and others also showed the presence of higher levels of synthetic chemicals in water, sediment and fish from Las Vegas Bay compared to reference sites.

Commonly used products known as emerging contaminants, such as triclosan (an antimicrobial drug), are being accumulated in fish from Las Vegas Bay.

Some of the chemicals present in Las Vegas Bay have been shown by laboratory studies to cause endocrine disruption in male fish.

Studies from 2006 to 2010 continue to find biomarkers indicating hormonal effects. These include presence of vitellogenin or egg yolk precursor in male carp; reduced testicular growth; lesions, kidney and liver abnormalities; and an intersexed ovary in carp.



Photo USGS

Potential Issues with Water Quality From Nutrients



2001 Algae Bloom
Worst Case Scenario



2011 – More Typical, and
More Likely Due to
Phosphorus Treatment
Enhancements By
Water Reclamation Districts

January 6, 2007
discovered
quagga mussels in
Lake Mead

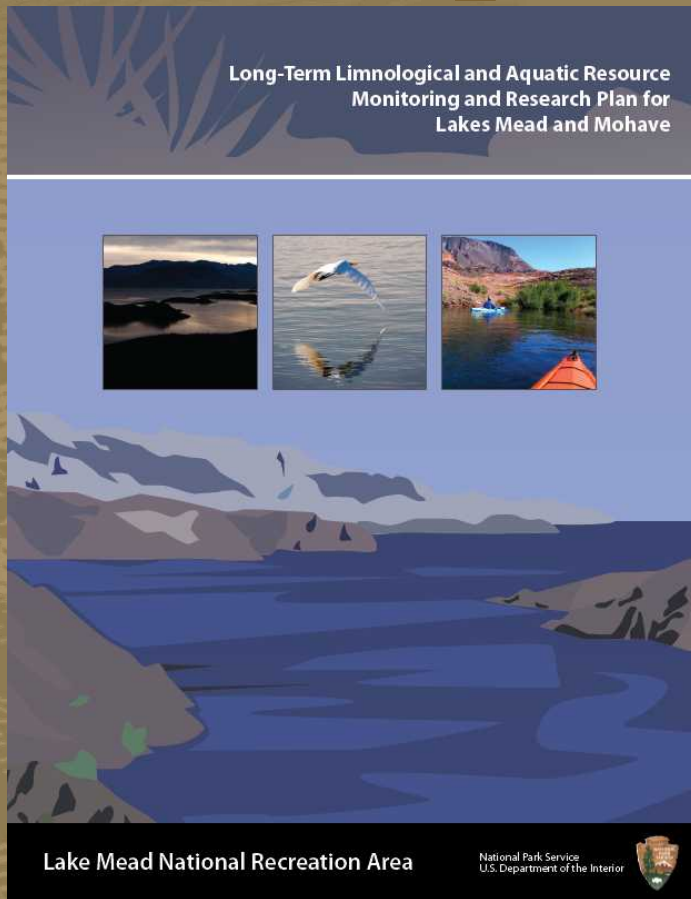


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Climate Change Models for Colorado River Predict From 5 to
20% Reduction in
Colorado River Basin Flows By 2050
Higher Probabilities of Longer Periods of Low Water



Interagency Partnership



National Park Service

Nevada Department of Wildlife

Southern Nevada Water Authority

U.S. Bureau of Reclamation

U.S. Fish and Wildlife Service

U.S. Geological Survey

Purpose of the Plan

A suggested long-term monitoring and research framework for the limnological and aquatic and water dependent resources and water quality of Lakes Mead and Mohave within Lake Mead NRA.

- Coordinate existing monitoring within framework of mutual objectives
- Provide an overview of the variety of efforts underway
- Prevent duplication of efforts and identify gaps
- Leverage funding opportunities
- Help document and archive data in a means that is useful to the contributing agencies, other agencies, and the public

Scope of the Plan

The plan geographically covers the surface waters within Lake Mead NRA and the basic limnological and water quality elements that relate to fulfilling the plan goals and including water-dependent natural resources.



Strategic Fundamental Objectives

Lakes Mead and Mohave maintain water quality that supports:

1. A healthy sport fishery.
2. Healthy populations of native fish.
3. Healthy populations of aquatic dependent wildlife.
4. Healthy populations of riparian, aquatic, and shoreline dependent native vegetation.
5. A high quality setting for water-based recreation.
6. Regional and community needs for municipal and industrial uses, including domestic water supply and Colorado River return flow credits.

Category 1
Water Quality

Category 2
Fish/Biota

Category 3
Stressors

Category 4
Sediments

Category 5
Birds

Category 6
Riparian Veg

Within Each of the Six Categories:

Key Category System Drivers

Key Category Components

Key Category Stressors

Priority Questions

Best Answered By Monitoring

Best Answered By Research

Category 1
Water Quality

Category 2
Birds/Biota

Category 3
Stressors

Category 4
Sediments

Category 5
Birds

Category 6
Riparian Veg

Within Each of the Six Categories:

Suggested Annual Monitoring Program

Suggested Five Year Research Program

Annual Data Analysis and Summaries

Five-Year Data Interpretation

Desired Future Conditions and Targets

Water Quality and Water Science

Selected System Drivers

- Volume of reservoirs as influenced by drought, climate change, and community needs
- Timing, quality, and volumes of tributary inflows related to floods and upstream tributary management
- Lake stratification
- Basic hydrology and circulation patterns related to wind, weather, and management

Selected Category Stressors

- Nuisance aquatic species
- Urban runoff
- Contaminants
- Human and wildlife pathogens
- Return of treated wastewater



Photo by LARRY PAULSON

Key Monitoring Questions

- What are the status and trends of physical and chemical water quality parameters (e.g., conductivity, dissolved oxygen, nutrients, temperature, transparency, pH, and water levels)?
- What are the status and trends of biological water quality parameters (e.g., plankton and chlorophyll-*a*)?
- What are the status and trends of contaminants in the water column [e.g., disinfection byproduct precursors, volatile organic compounds (VOCs), radionuclides, priority pollutants (EPA and State), and pathogens]? (see also Category 3).

Key Research Questions

- What are the relationships between any changes in wastewater management, tributary inflows, and climate and impacts to water quality parameters, drinking water, fish, aquatic dependent wildlife, and recreation?
- How does water column stratification affect the position or distribution of tributary inflows?
- What are the mass transport and internal cycling budgets for contaminants and nutrients?
- What is the impact of changes in operations at Glen Canyon Dam and Hoover Dam on water quality?

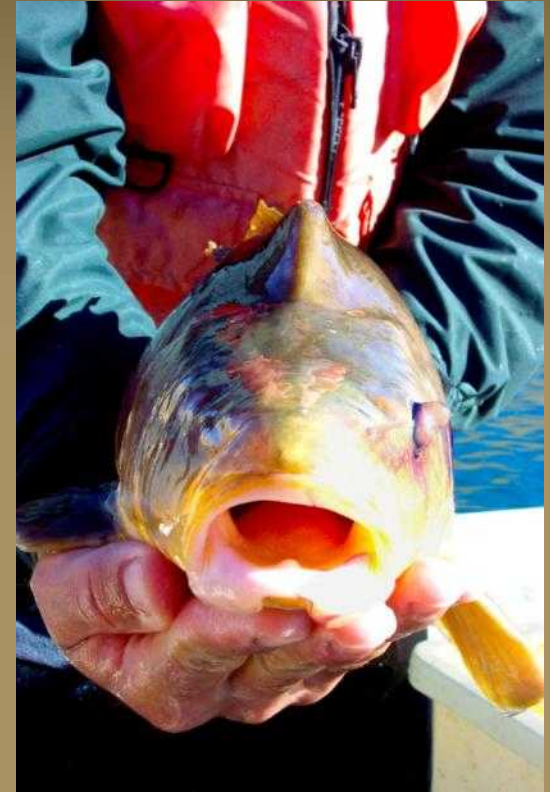
Fish and Aquatic Biota

Key Category Drivers

- Lake levels and tributary flows
- Lake temperatures for spawning
- Suspended sediments
- Food source/prey base (e.g., nutrient inputs, phytoplankton/zooplankton, and shad)
- Benthic food source for benthic-driven species

Key Category Stressors

- Contaminants
- Nutrient availability
- Viruses and pathogenic bacteria
- Invasive species such as quagga mussels
- Habitat modification
- Drought and climate change



NPS Photo

Stressors

Contaminants
Invasive Species
Climate Change



Photo by NPS SUBMERGED RESOURCES CENTER

- Alterations to the environment and community structure by contaminants, invasive species, and/or climate changes will affect food webs and dynamics within Lakes Mead and Mohave, likely causing profound changes to their respective ecosystems.

Sediment

Selected System Drivers

- Contaminant release proceeds through porewater
- Contaminant release depends upon dissolved oxygen (DO) concentration, pH, temperature, binding strength, and ionic strength of the immediately adjacent water layer
- Urban runoff and delivery by tributaries and floodwaters
- Las Vegas Wash and Bay are areas of unique sediment activity (e.g., deposition, effects to fishery, contaminant sinks)

Selected Stressors

- Treated wastewater returned to Lake Mead from urban corridors along Virgin River, Moapa Valley, and Las Vegas Valley
- Illegal dumping into storm drains and lakes
- Human pathogens introduced via recreation
- Livestock/wildlife pathogens introduced via grazing or other water use



Photo by MICHAEL ROSEN, USGS

Birds

Key Category System Drivers

- Food resource abundance and quality
- Habitat availability and quality (namely water)
- Influence of weather patterns on migration patterns

Key Category Stressors

- Habitat modification (e.g., invasive plant species encroachment on shorebird nesting and foraging grounds)
- Contaminants
- Pathogenic bacteria and viruses
- Grazing by horses, cattle, and burros to include trampling of shorebird nesting sites
- Habitat destruction by wildland fire
- Climate change



Photo by JOSEPH BARNES, UNLV

Riparian Vegetation

Key Category System Drivers

- Lake water levels
- Sediment deposition and erosion rates

Key Category Stressors

- Alterations in groundwater dynamics, including depth to groundwater
- Altered surface water dynamics and rapidly changing water levels
- Rates of stream and shoreline geomorphic processes of erosion and deposition in relationship to plant recruitment and growth
- Pollinators and propagule dispersal mechanisms



Photo by JOSEPH BARNES, UNLV

Synergy, not Redundancy

The plan does not:

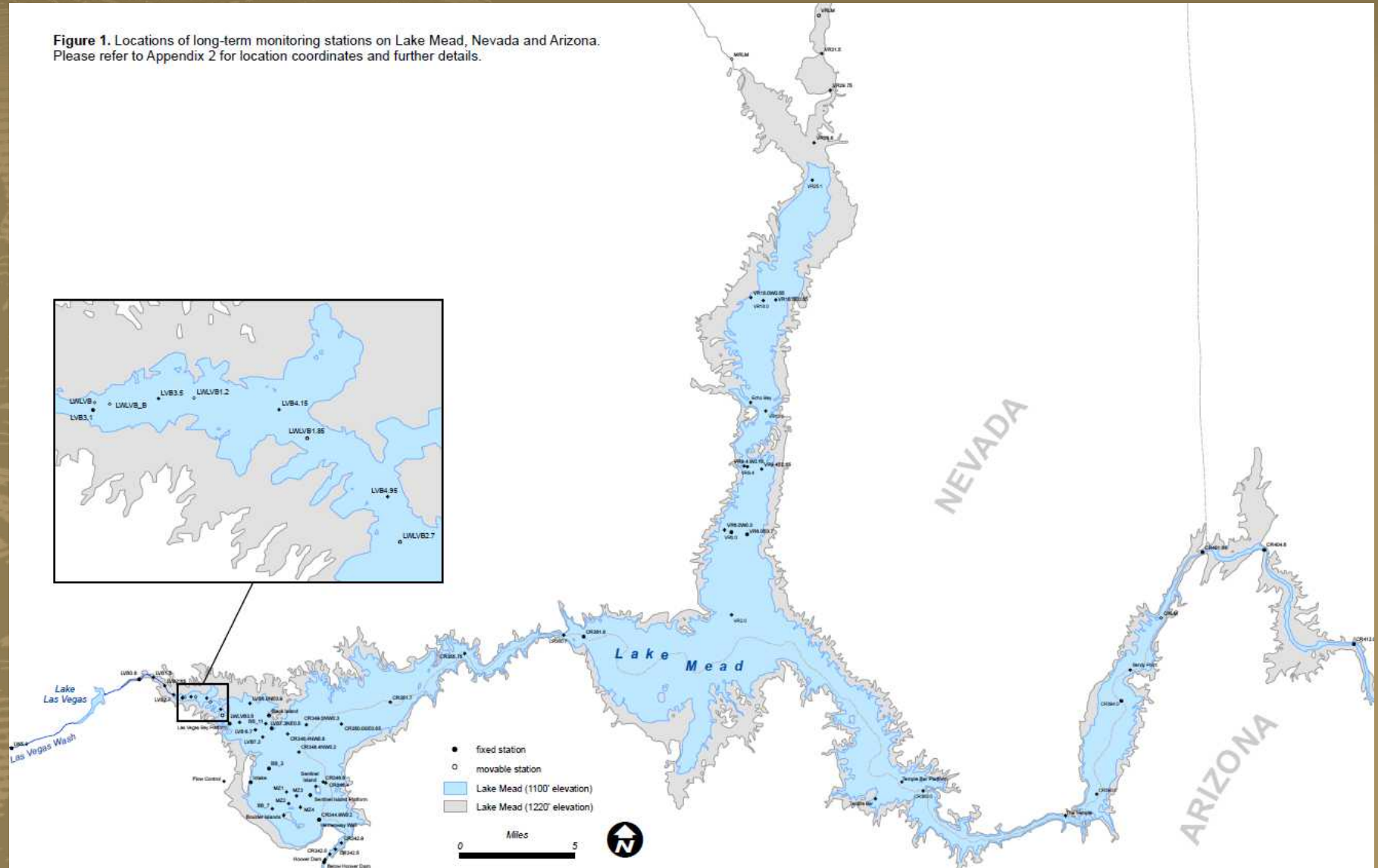
- Replace any other authorities
- Obligate the expenditure of funds by any of the contributing agencies
- Obviate any responsibility or authority of any of the contributing agencies.



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Map of Lake Mead Stations

Figure 1. Locations of long-term monitoring stations on Lake Mead, Nevada and Arizona. Please refer to Appendix 2 for location coordinates and further details.



Data Management

This plan does not develop data-management structures; it encourages the continued use of existing data management mechanisms such as:

- The SNWA Members Website

www.snwawatershed.org

- USGS Online Data and Reports

<http://nevada.usgs.gov/lmqw/>

http://nevada.usgs.gov/water/projects/regional_references.cfm?Reg=24

Web Site

The screenshot shows the nps.gov website with the 'Lakes' section highlighted. The page features a search bar, navigation links, and a list of lakes including Lake Mead, Lake Mohave, and Lake Science (limnology). A 'Did You Know?' section at the bottom features a photo of a ram and text about desert bighorn sheep.


nps.gov National Park Service U.S. Department of the Interior


search go


Search this park
 Search nps.gov

Lake Mead
National Recreation Area
view map text size: A A A printer friendly

Lakes

 **Lake Mead**

 **Lake Mohave**

 **Lake Science (limnology)**

Did You Know?
Desert Bighorn sheep live in matriarchal societies. A dominant female leads a herd, which for much of the year consists primarily of ewes and their lambs. The rams tend to stay together in bachelor groups until the

The screenshot shows the nps.gov website with the 'Lake Science (limnology)' section highlighted. The page features a search bar, navigation links, and a list of topics including Water Quality and Limnology, Fish and Aquatic Biota, Stressors, Sediment, Birds, and Riparian. A 'Did You Know?' section at the bottom features a photo of Hoover Dam and text about its construction.

nps.gov National Park Service U.S. Department of the Interior

search go

Search this park
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Lake Mead
National Recreation Area
view map text size: A A A printer friendly

Lake Science (limnology)

Water Quality and Limnology

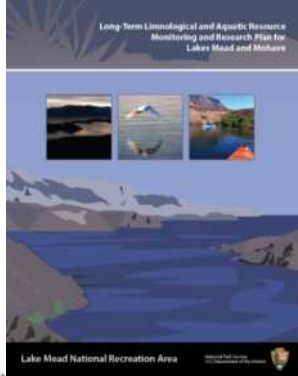
Fish and Aquatic Biota

Stressors

Sediment

Birds

Riparian

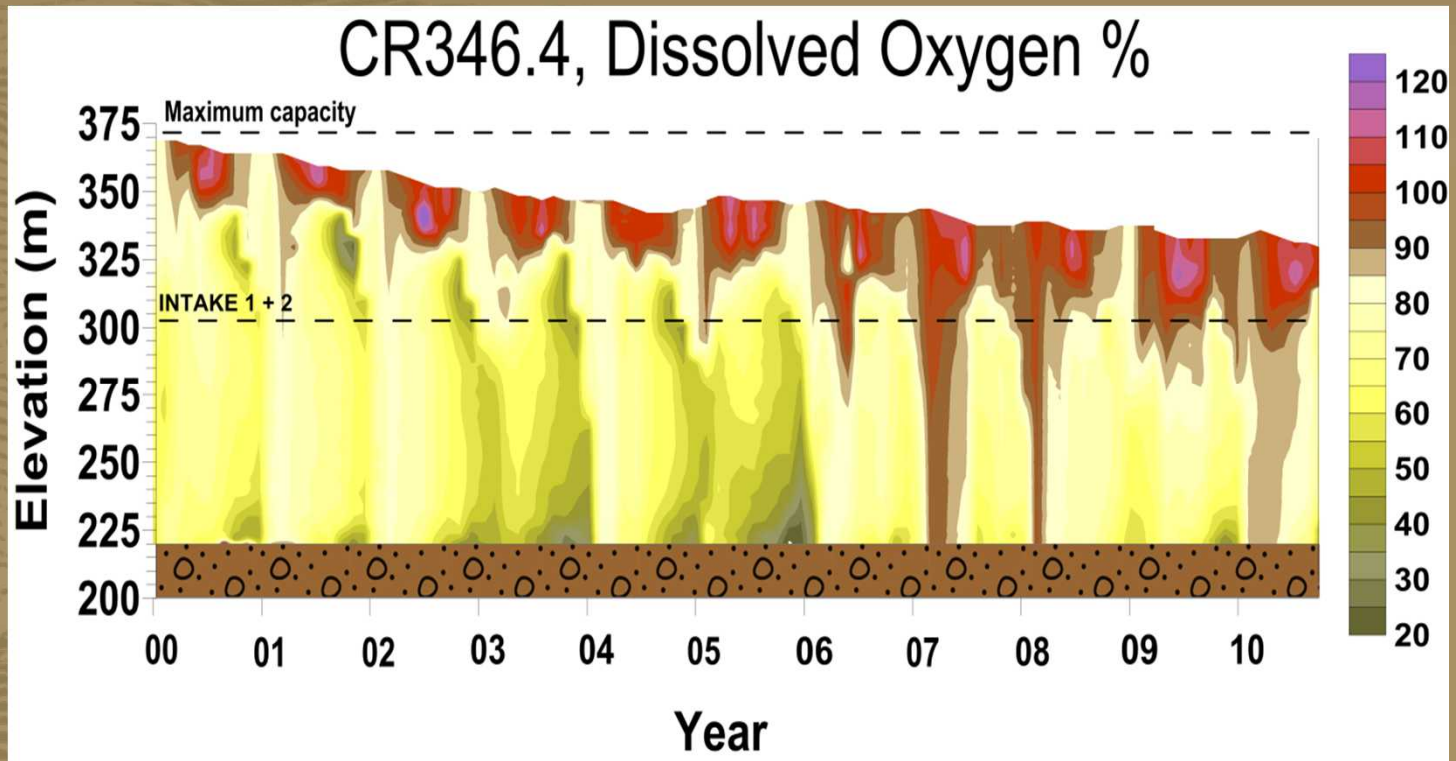


Did You Know?
Hoover Dam was the first major dam to span the wild Colorado River. One hundred twelve workers died before it was finished in 1935.

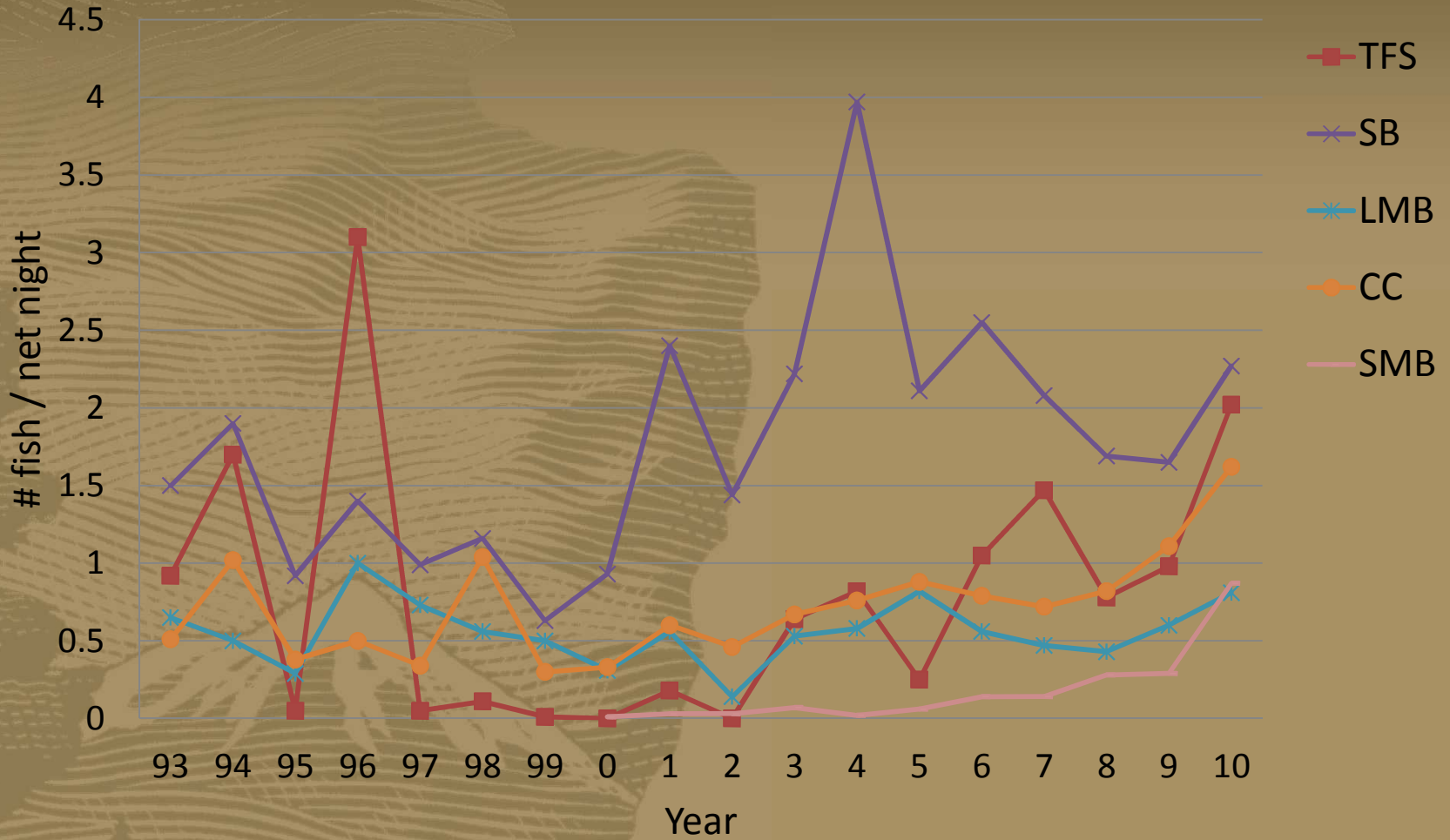
<http://www.nps.gov/lake/naturescience/lakes.htm>

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Annual Data Summaries



Gill net CPUE



Nevada Division of Wildlife

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Future?

Partnerships:

Lake Mead Ecosystem Monitoring Work Group

1. Common Objectives
2. Shared Resources
3. Data Analysis Towards Trends/Objectives

Lake Mohave Monitoring

Web Based Living Document

- Data Summaries
- Key Management Documents
- Key Findings
- Structure for Analysis
- Public Outreach

<http://www.nps.gov/lake/naturescience/lakes.htm>

