

# Surface water monitoring for indicator bacteria in high-use sites of the Lake Mead National Recreation Area 2003-2011

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# Project Description

- Study sites – 10 high-use areas
- Sampling Time and Frequency
  - High-use months (May thru September)
  - Twice per month
  - Samples collected following holidays
- Sample collection
  - 20-30 feet from shoreline
  - 0.5 meter depth below the surface
  - Processed SNWA microbiology laboratory
  - Water temperature, air temperature, boats, visitors vehicles, comments on weather

# Sampling



## Criteria for bacterial density in recreational waters for the four indicator bacteria monitored in this study (CFU = colony forming units)

Indicator Bacteria	Recommended Limit (CFU/100 ml)	Reference
Enterococci	62 <sup>a</sup>	EPA, 1986 and 2002
<i>Escherichia coli</i>	235 <sup>a</sup>	EPA, 1986 and 2002
Fecal coliforms	200	EPA, 1986 and 2002
Fecal streptococci	200 <sup>b</sup>	EPA, 1997

<sup>a</sup> single sample

<sup>b</sup> standards are not available because the enterococci have replaced fecal streptococci for that specific test; value was assigned based on the fecal coliforms recommended limit

# Water Quality Monitoring on Lake Mead and Lake Mohave

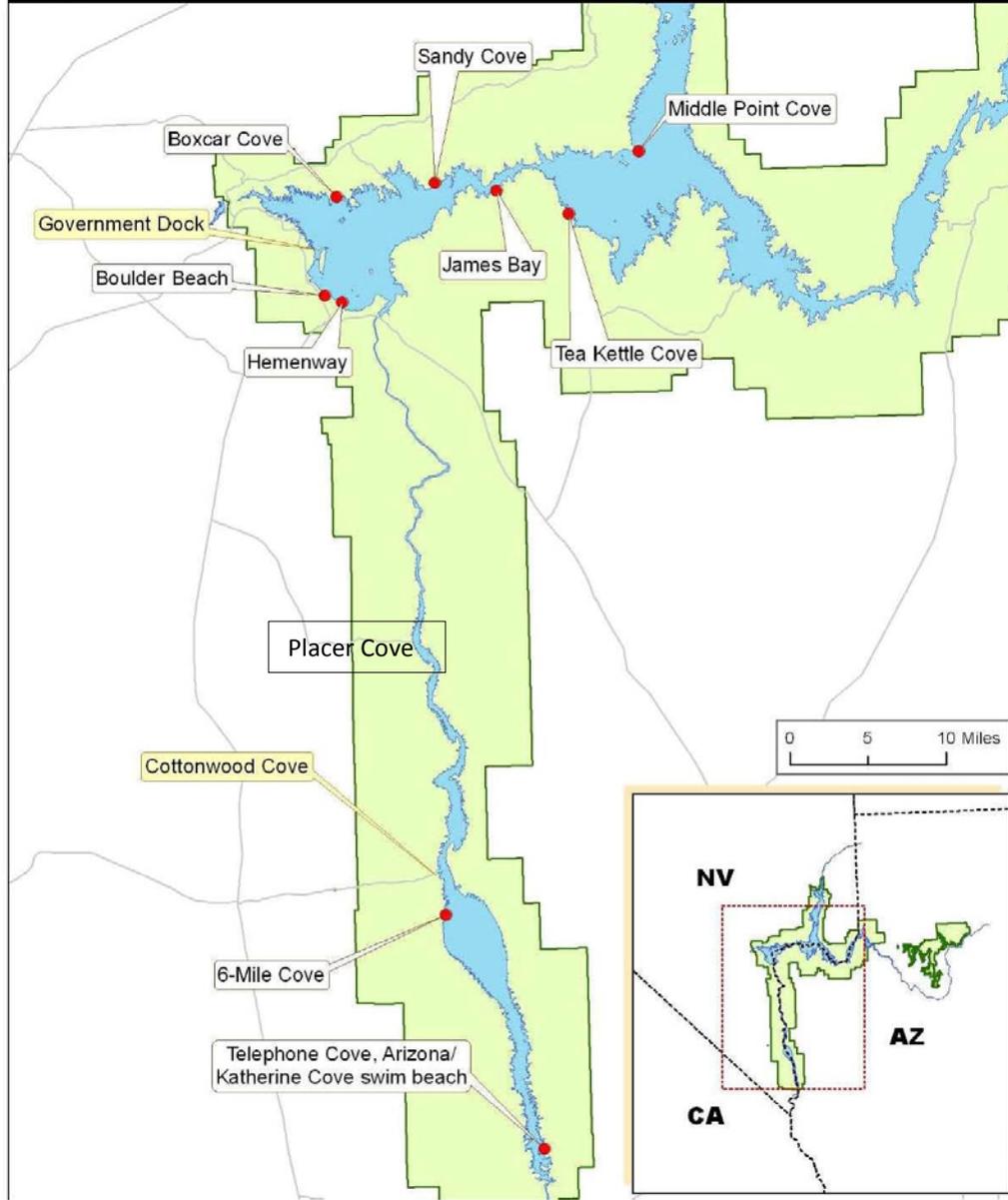
May 2008



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# Results

- *Escherichia coli* – 4 instances/655 samples (0.6%)
- Enterococci – 30 instances/ 496 samples (6.0%)
- Fecal streptococci – 34 instances/649 samples (5.2 %)
- Fecal Coliforms – 20 instances/655 samples (3.1 %)

# Water Quality Monitoring on Lake Mead and Lake Mohave

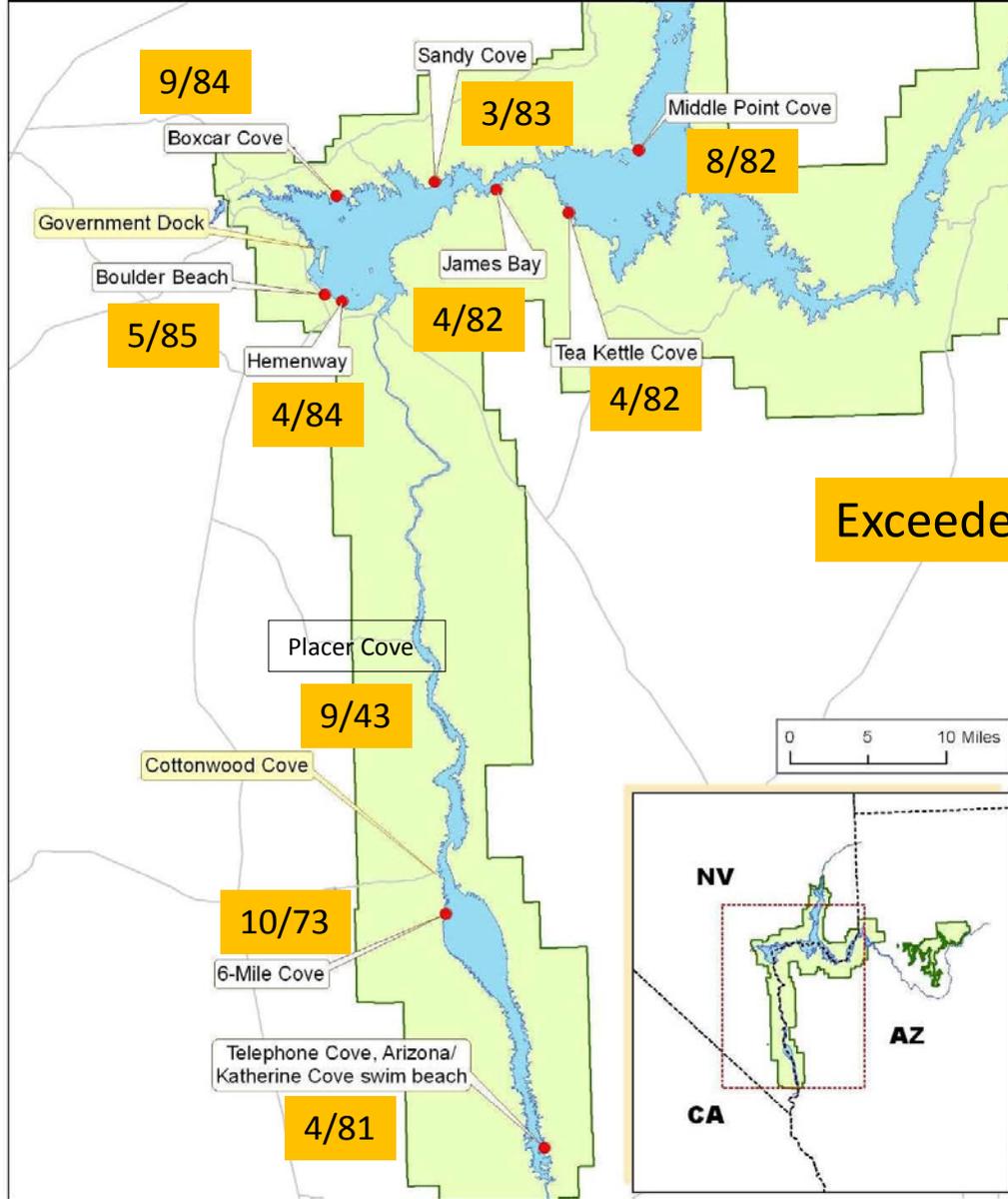
May 2008



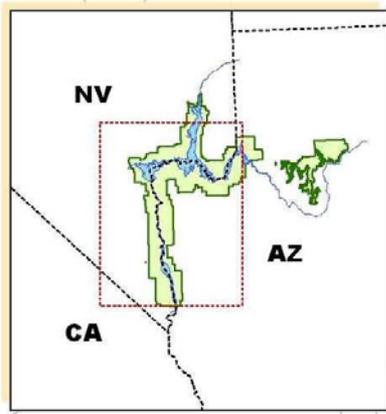
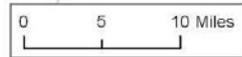
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Exceeded limits/Total Samples



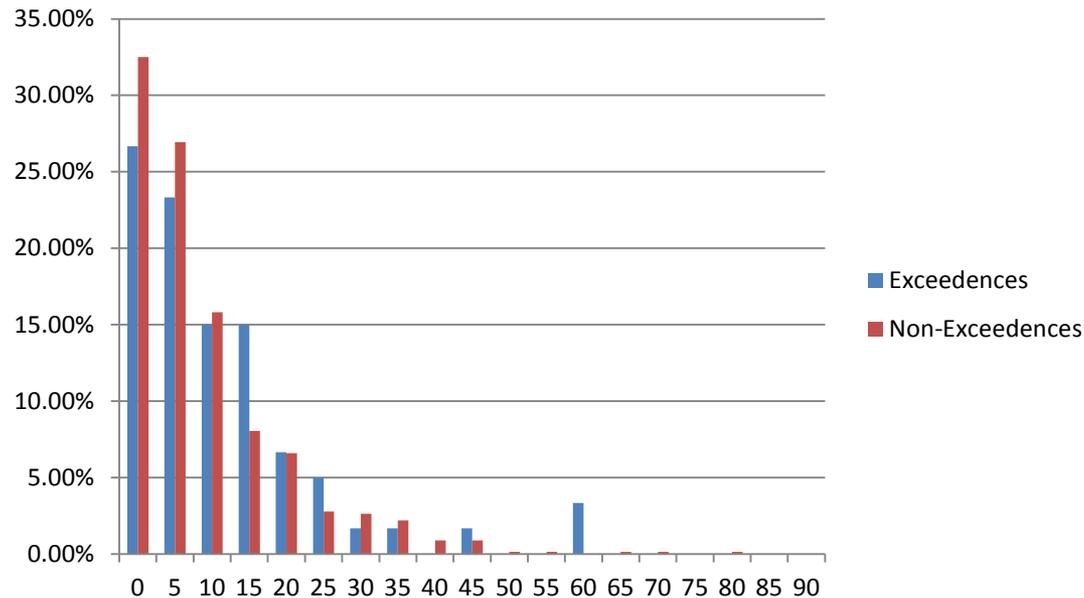
# Discussion

- Potential factors
  - Visitation
  - Water temperature
  - Wind and waves

# Visitation

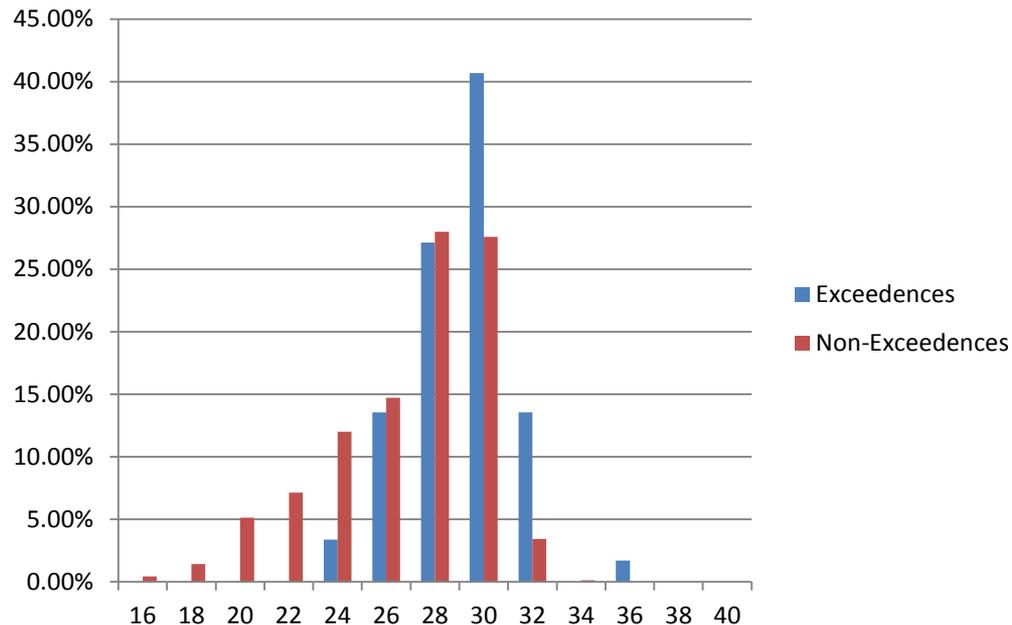
Exceeded - Mean 10.0, Median 5.5

Non-Exceeded - Mean 7.5, Median 4



# Water temperature °C

- Exceeded - Mean 28.1 Median 28.3
- Non-Exceeded - Mean 26.0 Median 27.0



# Water Quality Monitoring on Lake Mead and Lake Mohave

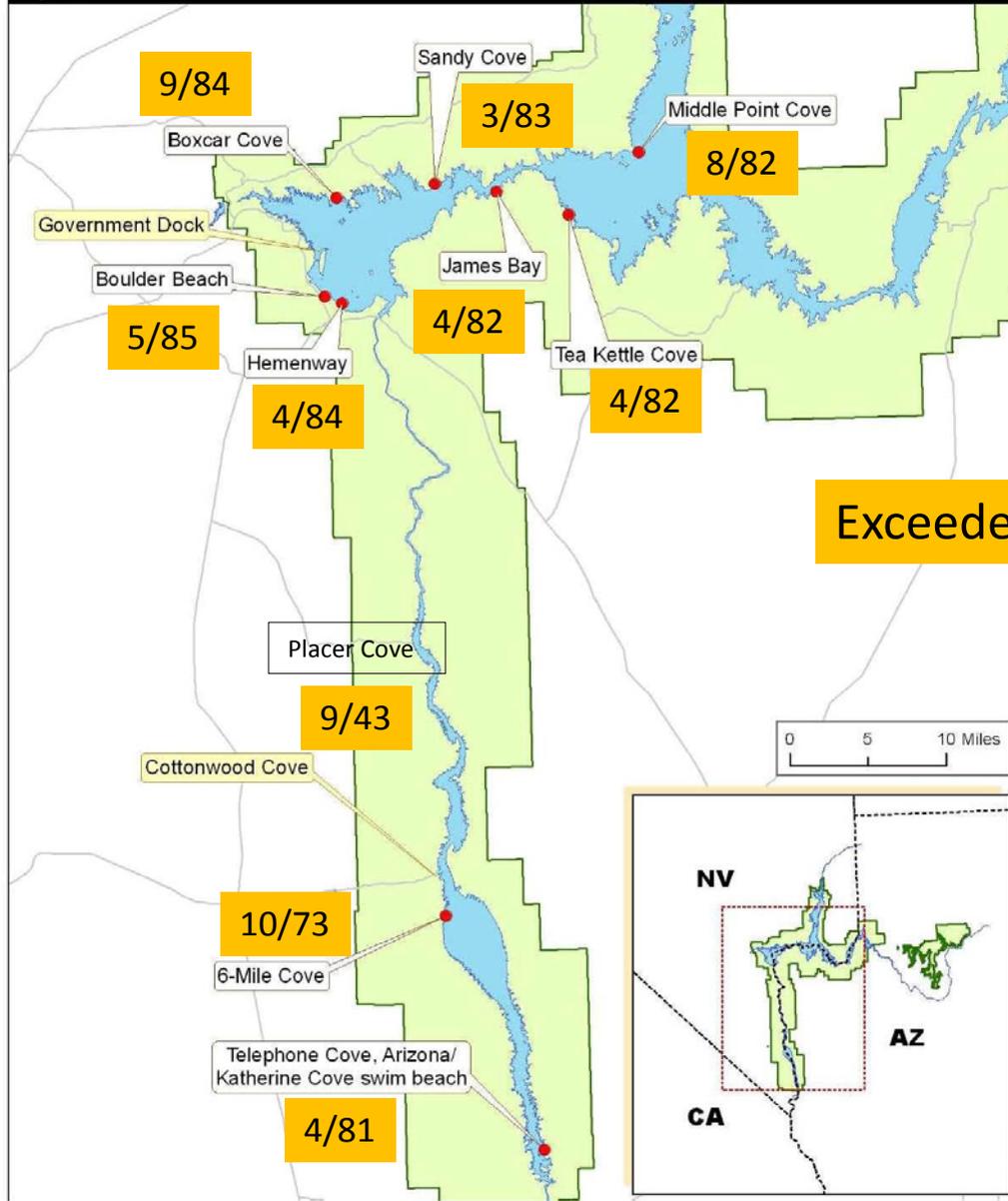
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Exceeded limits/Total Samples



Summer Winds

# Wind

- Method –
  - Evaluate highest wind velocity and wind direction for the prior 24 hours for each sampling event
  - Use wind information from USGS monitoring stations on the lake in Boulder Basin (Sentinel Island) and Virgin Basin (2005-2010)
  - Compare wind velocities for sampling events where bacterial limits were exceeded to sampling events where limits were not exceeded

# Wind – 7/25/11 Sampling Event

Time (PST)	Wind Speed (meters/second)	Wind Direction (azimuth degrees)
2201	4.10	139.80
2301	2.94	175.00
101	2.53	192.10
201	7.82	132.40
301	<b>9.58</b>	<b>121.30</b>
401	8.33	127.20
501	9.31	137.90
701	9.02	137.10
758	7.24	113.90
<b>858</b>	<b>6.97</b>	<b>123.50</b>
<b>958</b>	<b>5.84</b>	<b>112.40</b>

# Results - Wind

- Among all measurements, there is no difference in maximum wind speed between exceeding events and non-exceeding events (T-test,  $df=682$ ,  $P = 0.238$ );
- For **Enterococci** count vs. maximum wind speed, positive correlation was found in Boulder Beach ( $P = 0.039$ ) and Boxcar Cove ( $P = 0.033$ ). However, no correlation was found in other locations ( $P > 0.05$ ). There was no correlation between count and wind direction in any of those locations ( $P > 0.05$ ). **For North facing areas, bacteria count positively correlated with wind speed ( $P = 0.039$ ). For other facing areas, no correlation was found; bacteria count had no correlation with wind directions at any facing direction**
- For **E. coli** count vs. maximum wind speed, positive correlation was only found in Hemenway ( $P = 0.035$ ), 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 ( $P > 0.05$ );**

# Results – Wind (cont'd)

- 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, no correlation was only found 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 ( $0.030$ ) area, but not in other facing areas ( $P > 0.05$ );**

# Conclusions

- Monitoring is identifying problem areas and needs to be continued
- Some high-use coves (e.g. Placer cover) 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