Occurrence of Organic Contaminants in the Lake Mead Region from 2002 to 2014

David Alvarez[1], Michael Rosen[2], Tammy-Jones Lepp[3], Michael Moran[4]

[1] US Geological Survey, Columbia, MO

[2] US Geological Survey, Carson City, NV

[3] US Environmental Protection Agency, Las Vegas, NV

[4] US Geological Survey, Henderson, NV

U.S. Department of the Interior
U.S. Geological Survey

Overview of USGS's monitoring studies

In 1995, USGS began using passive sampling devices as an alternate means of measuring organic contaminants in Lake Mead and Las Vegas Wash.

Subsequent studies have been conducted partnering with multiple Federal and State agencies and Universities investigating not only chemical occurrence, but also potential linkages to fish health.

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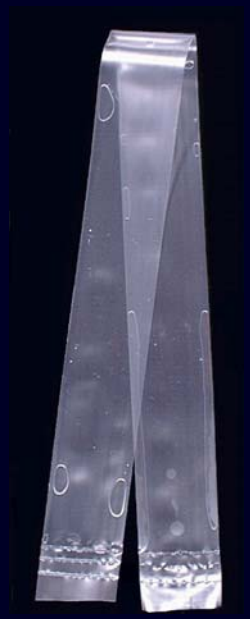
Passive samplers used for monitoring organic chemicals

- Semipermeable Membrane Device (SPMD)
  - Lipid soluble chemicals (log K_{ow} > 3)
  - Triolein (lipid) filled PE tube
  - Useful for both water and air sampling



SPMD

- Polar Organic Chemical Integrative Sampler (POCIS)
  - Water soluble chemicals (log K_{ow} < 3)
  - Solid phase sorbents held between PES membranes
  - Sorbents and membranes can be changed for specific applications

POCIS

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Passive Sampling Studies

Year	Sampler Type	Target Chemicals and Bioassays
1995	SPMDs	OCs, PAHs, Dioxins/Furans
1		
2004-2006	SPMDs	PAHs
2002-2003	POCIS	Pharmaceuticals, Illicit Drugs
2005	SPMDs/POCIS	OCs, PCBs, PAHs, OWCs, Pharmaceuticals, Illicit Drugs, Pesticides, Estrogens, YES
2006	SPMDs/POCIS	OCs, PCBs, PBDEs, PAHs, OWCs
2008	POCIS	Pharmaceuticals, Illicit Drugs
2008	SPMDs/POCIS	OCs, PCBs, PBDEs, PAHs, OWCs, Pharmaceuticals, Illicit Drugs, YES
2010	SPMDs/POCIS	OCs, PCBs, PBDEs, PAHs, OWCs, Pharmaceuticals, Illicit Drugs, YES
2012	POCIS	Pharmaceuticals
2013-2014	SPMDs/POCIS	OCs, PCBs, PBDEs, PAHs, OWCs, YES

Not Included in Following Discussion

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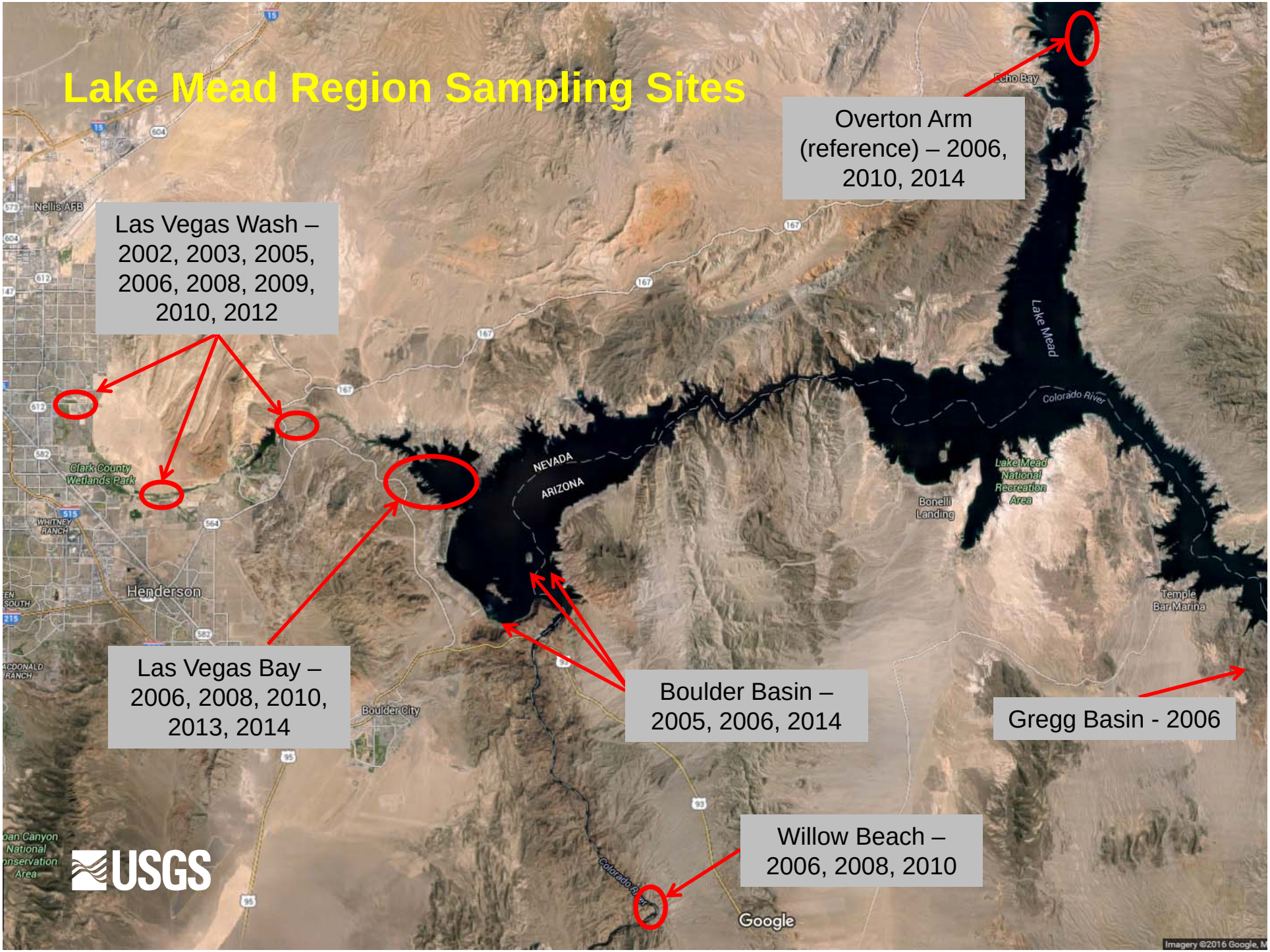
OCs – organochlorine pesticides; PCBs – polychlorined biphenyls; PBDEs – polybrominated diphenyl ethers; PAHs – polycyclic aromatic hydrocarbons; OWCs – organic wastewater chemicals; YES – yeast estrogen screen

Lake Mead Region Sampling Sites

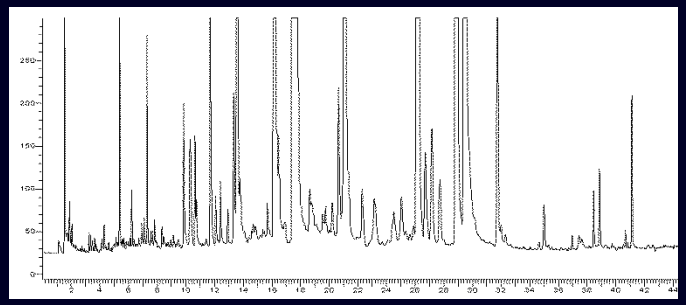


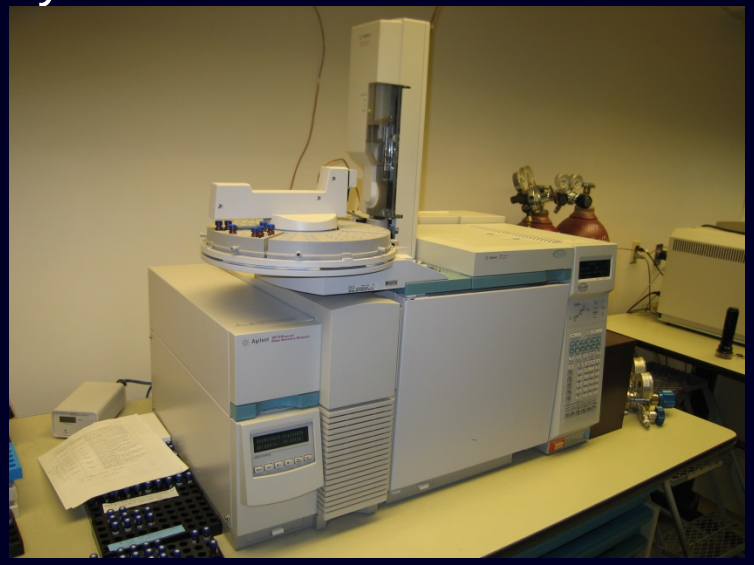
Comparability of Data between Studies

Summer

- 210 individual analytes measured between 2002-2014
  - 36 common chemicals in all SPMD studies between 2005-2014
  - No common chemical measured in all POCIS studies

- Study design and common methods/analyte lists were considered during data evaluation





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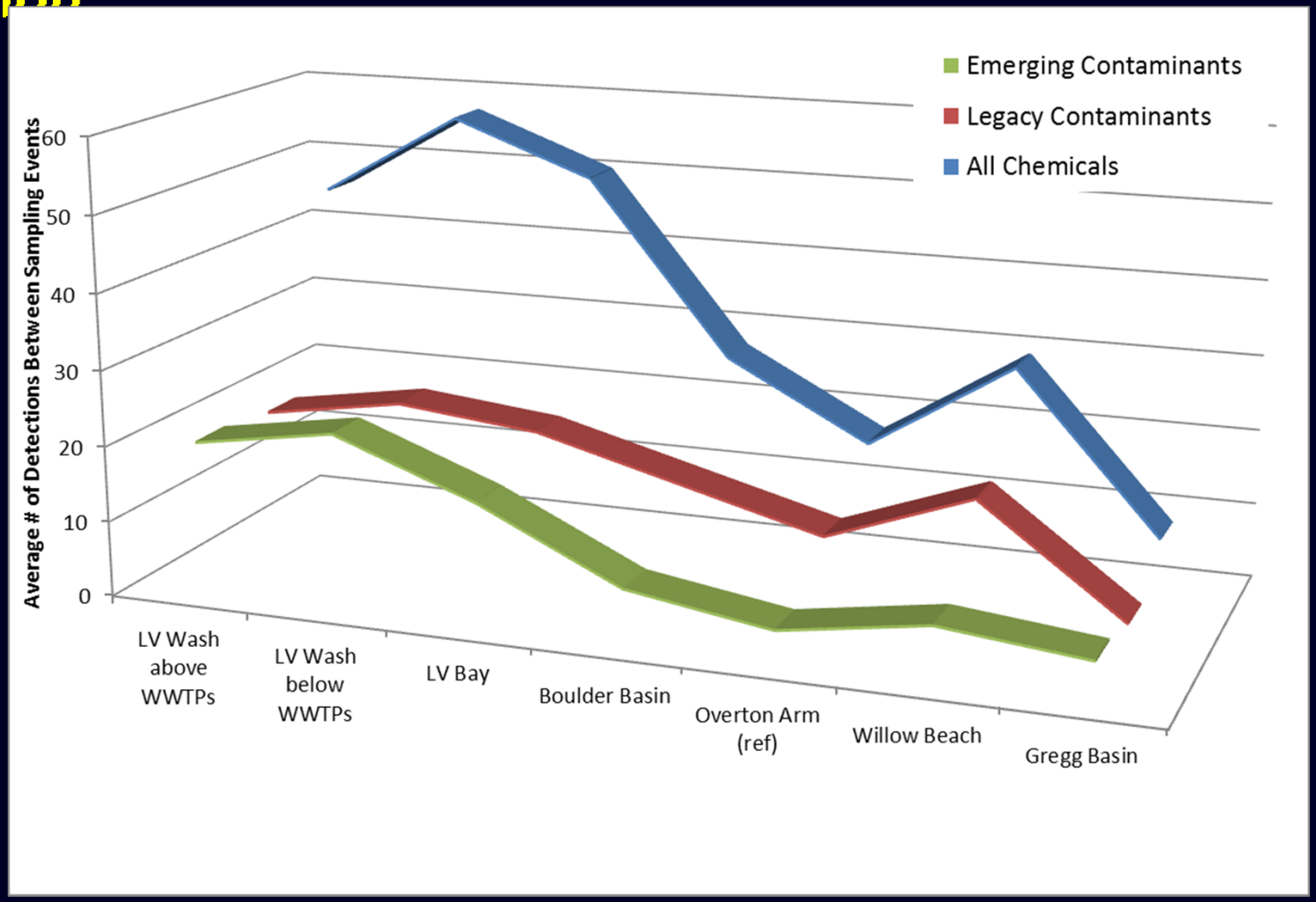
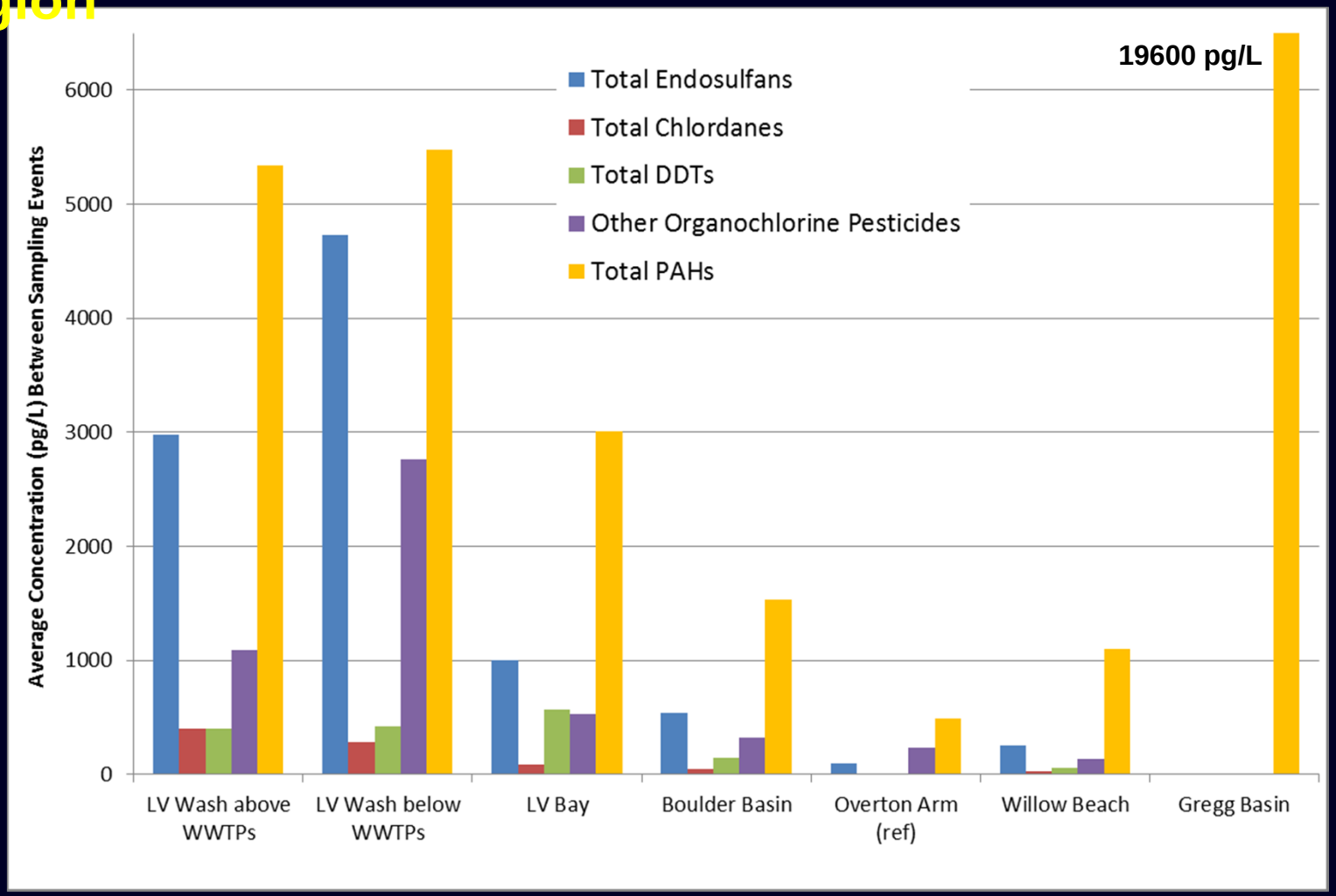
Spatial Distribution of Contaminants in the Lake Mead Region



In general, the total number of chemicals are highest in LV Wash and decrease with distance from the Wash.

Spatial Distribution of Contaminants in the Lake Mead Region



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Legacy and Hydrophobic Organics

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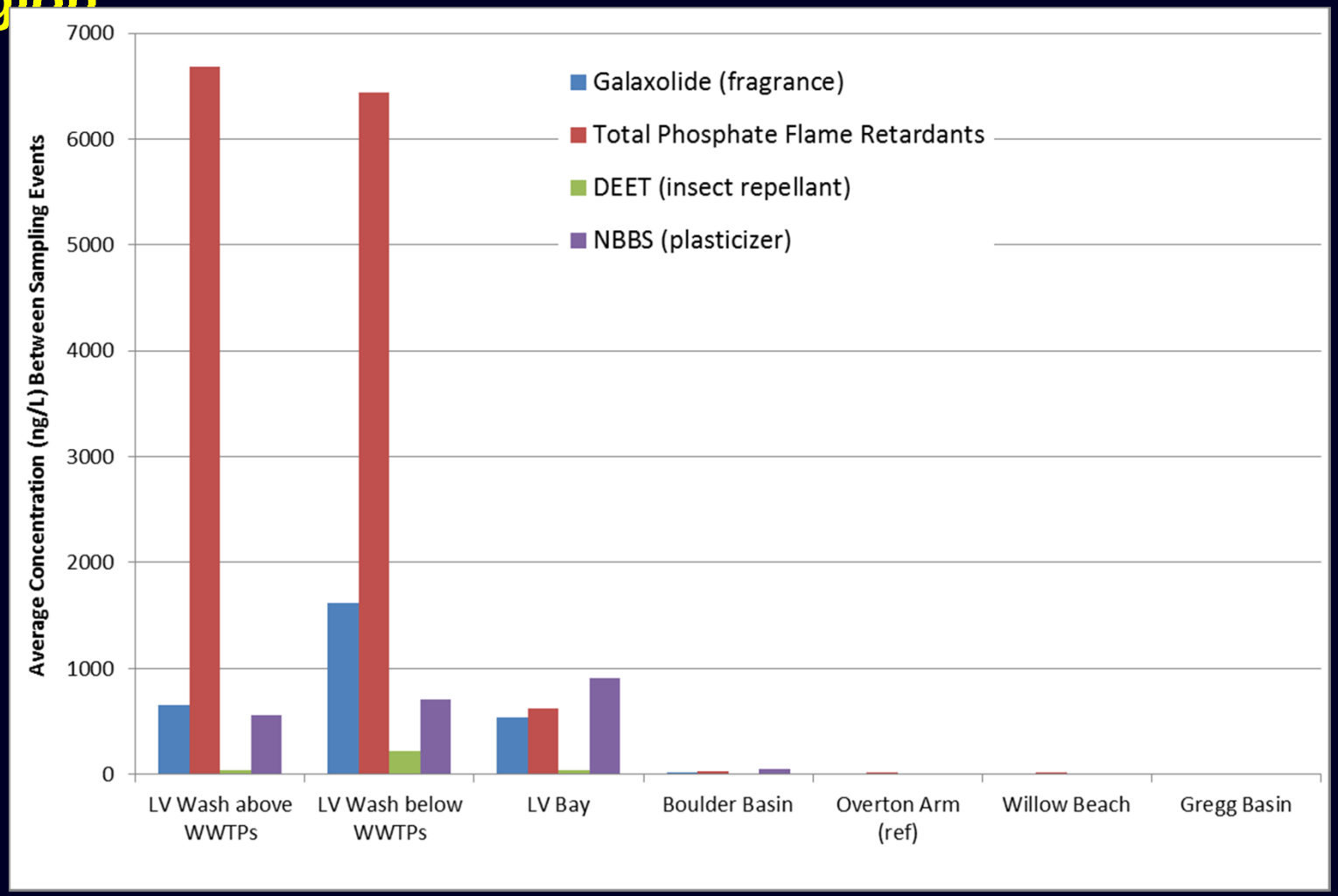

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Emerging Contaminants

Temporal Distribution of Contaminants in the Lake Mead Region

- Changes in chemical concentrations over time were difficult to assess due to:
  - Different suites of chemicals targeted in individual studies
  - Changes in labs/methods/detection limits between studies
  - Limited sampling at some sites
  - Changes in sampling locations within an area largely due to water accessibility

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Temporal Trends in Las Vegas Wash and Las Vegas Bay

- Las Vegas Wash (n=3) and Las Vegas Bay (n=5) have the greatest amount of data for comparison
  - No significant changes in concentration observed for any chemical
  - Galaxolide and the Phosphate Flame Retardants may be showing increases in concentration between 2005 and 2014, but a true evaluation of trends was not possible due to incomplete data from 2006.

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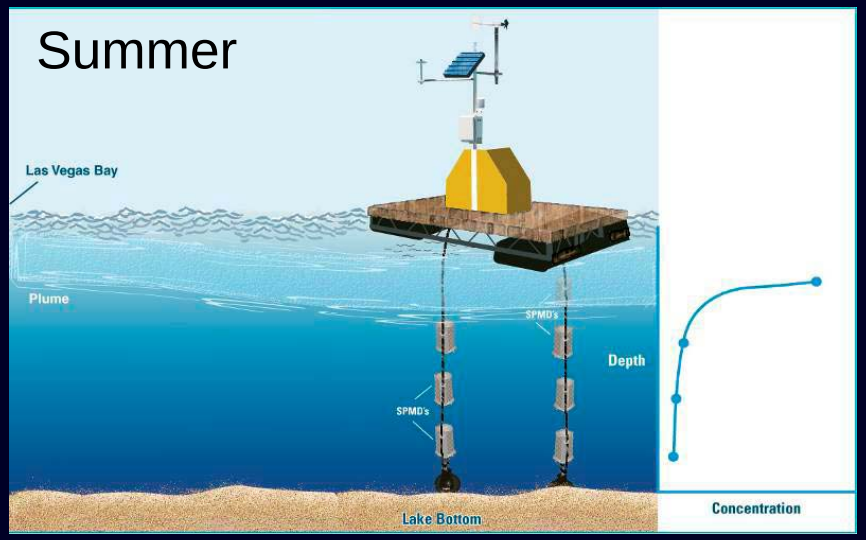
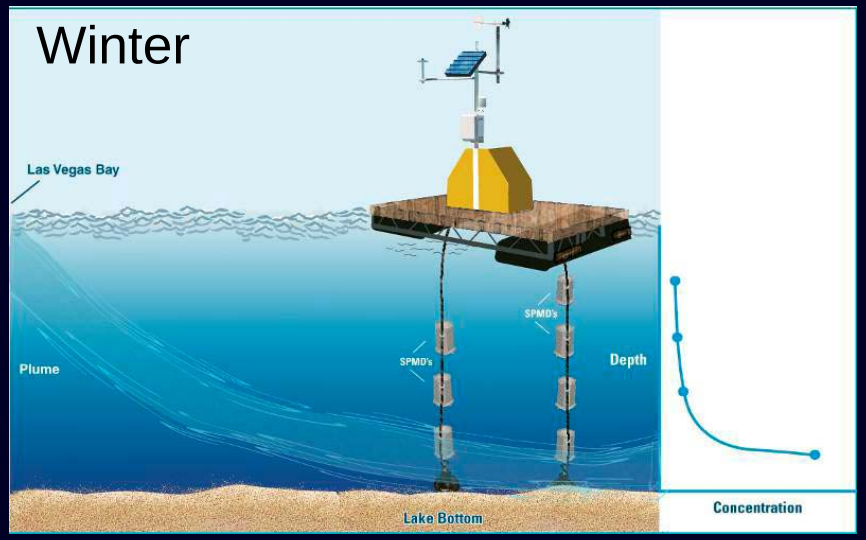
Vertical Distribution of Contaminants in Las Vegas Bay





The contaminant plume from LV Wash travels into Lake Mead at different depths depending on the time of the year.

In 2006 and 2008, passive sampling devices were placed at different depths in LV Bay to determine if contaminants were following the plume or were distributed based on other factors.

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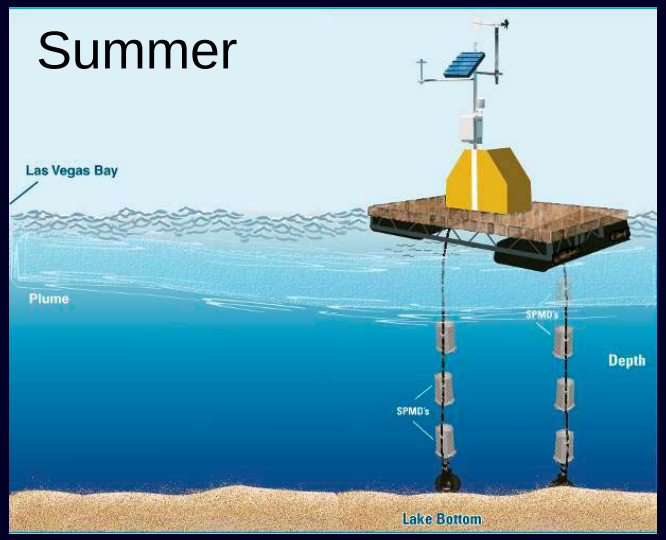

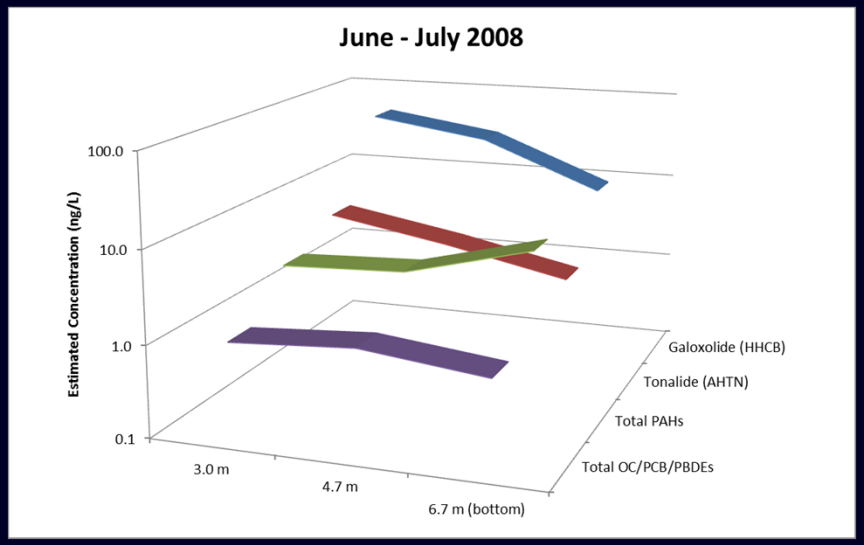

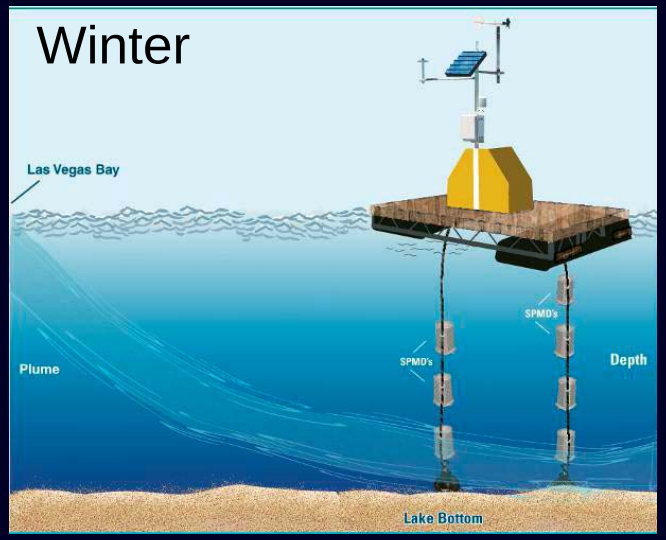

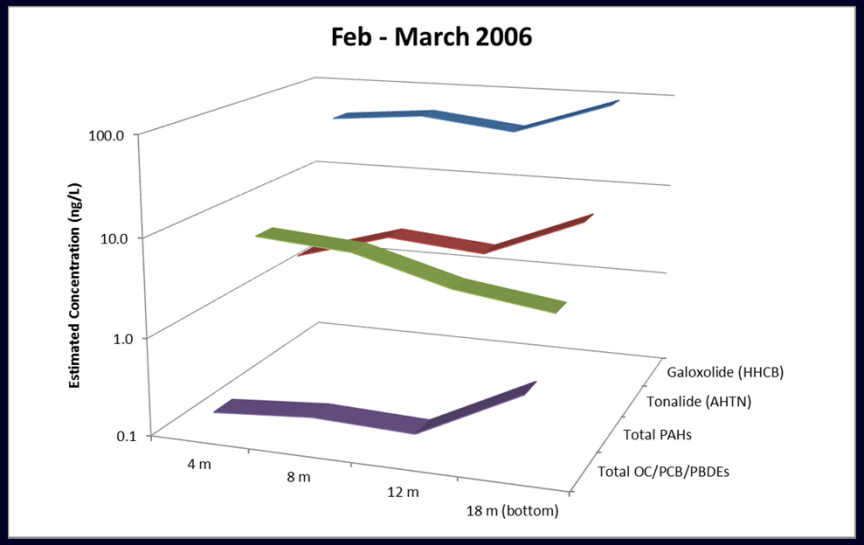

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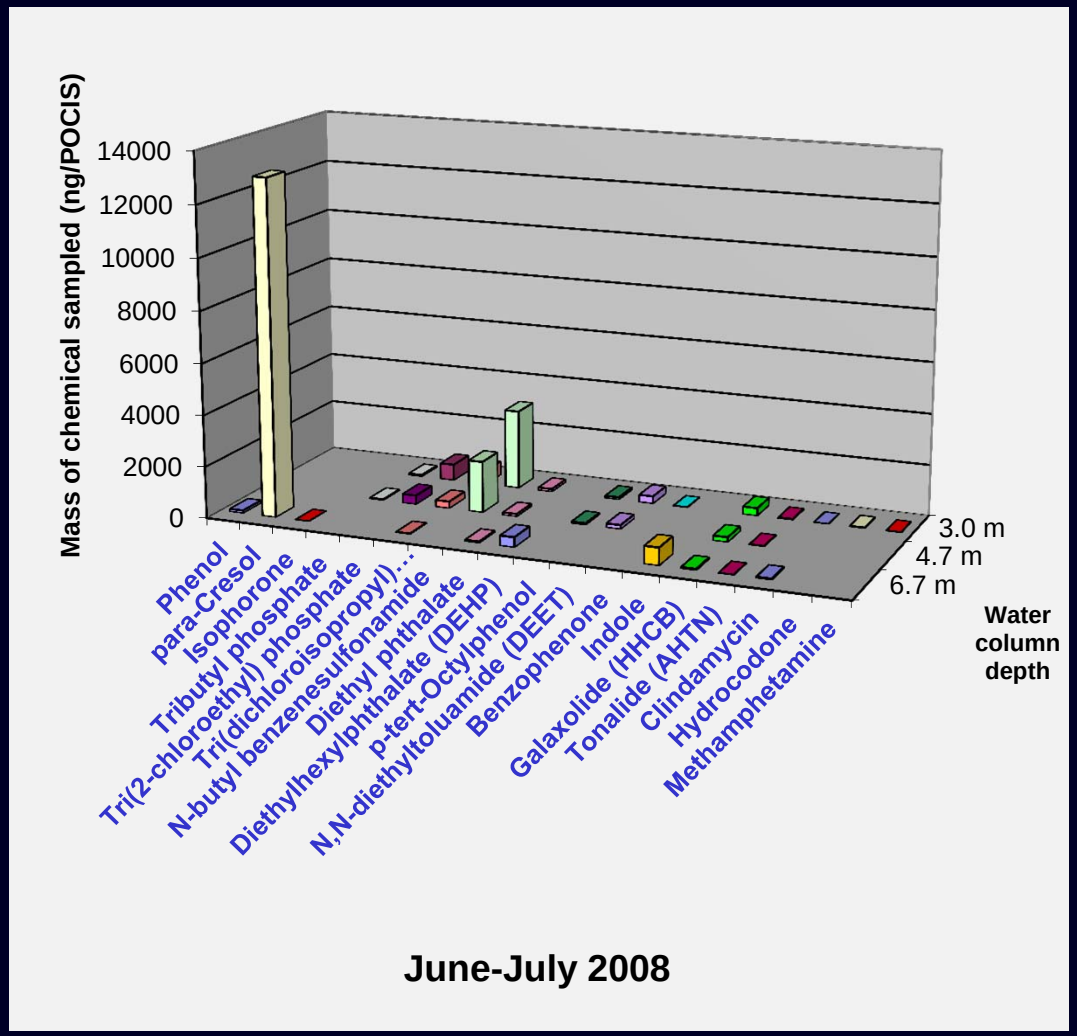

Chemicals with higher water solubilities tend to follow the plume across the lake surface.

Hydrophobic chemicals were present at the highest concentration near the sediment surface suggesting the sediment may act as a secondary source of contaminants.

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Conclusions

- Since 2002, there has been multiple studies focusing on the presence of legacy and emerging contaminants entering Lake Mead
- As expected, the maximum number of detections and concentrations are in LV Wash followed by LV Bay. These numbers quickly decrease as the water moves through the system.
- Concentrations of legacy contaminants remain largely unchanged between 2005-2014.
- Some emerging contaminants may be increasing in concentration; however, there isn't sufficient data to predict a true trend.

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More information

- Bevans et al., 1996, USGS Water Resources Investigations Report 96-4266.
- Covay and Leiker, 1998, USGS Open-File Report 98-633.
- Jones-Lepp et al., 2004, Archives of Environmental Contamination and Toxicology, 47: 427-439.
- Lico and Johnson, 2007, USGS Scientific Investigations Report 2007-5144.
- Rosen et al., 2010, Journal of Environmental Quality, 39: 1161-1172.
- Jones-Lepp et al., 2012, Science of the Total Environment, 430: 237-245.
- Alvarez et al., 2012, Chemosphere, 88: 605-611.
- Jones-Lepp et al., 2015, Analytical Bioanalytical Chemistry , 407: 6481-6492.

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