The Salton Sea Environmental Crisis:

Tracking Sources and Sinks of Pollutants and their Ecological Impacts

Author: Caroline Hung, PhD Candidate, Lyons Biogeochemistry Lab
Dept. of Earth and Planetary Sciences, University of California, Riverside

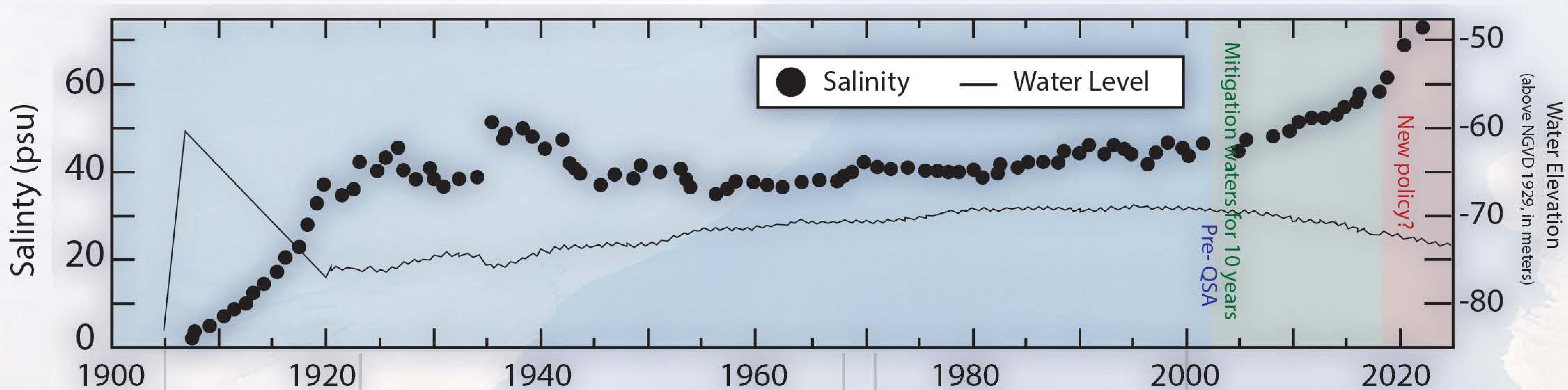
Aerial photo shows the arid lanscape in which the Salton Sea resides. Untreated agricultural return flow via tributaries and smaller canals has sustained the lake for the last century despite its rapid shallowing under further water diversions. However, this has introduced consistent and large supply of nutrients into the lake, and their environmental impacts have been negative.

Abstract

The Salton Sea, California's largest lake, is experiencing an environmental crisis fueled by historical water policies and agricultural practices in the region. This packet serves as an introductory outline to explore pollutant sources and sinks so researchers can use this information to study pollutants' trajectory and impacts on community health. We present a historical timeline of water policies to demonstrate the link between untreated agricultural runoff and the lake's ecological degradation. Graphs of lake elevation and salinity concentrations from the lake's flooding in 1905 to the present day highlight the sensitivity and dynamicity of environmental responses to water diversion and policies. Spatial mapping of nutrient concentrations (phosphates and nitrates) in the lake's major tributaries (Whitewater River, New River, and Alamo River) identifies key areas of nutrient loading at riverine mouths, which are suggested areas for further sampling for toxins. A conceptual illustration shows the biogeochemical cycling of these nutrients through the sediments, water column, and air, considering factors like seasonal temperature variations and patterns of lake circulation, and their impacts on microbial metabolisms and wildlife in the lake. The packet concludes with common questions and answers about the lake's pollution issues and emphasizes areas needing further research to inform effective lake management, clean-up, and policy decisions.

I. Relationship of Water Supply and Salinity in a Terminal Lake-

The runaway problem with untreated agricultural drainage collection via excessive nutrient loading and impacst from eutrophication



1905: Floods overwhelmed a diversion of the Colorado River, allowing flow into the Salton Basin, which created the lake.

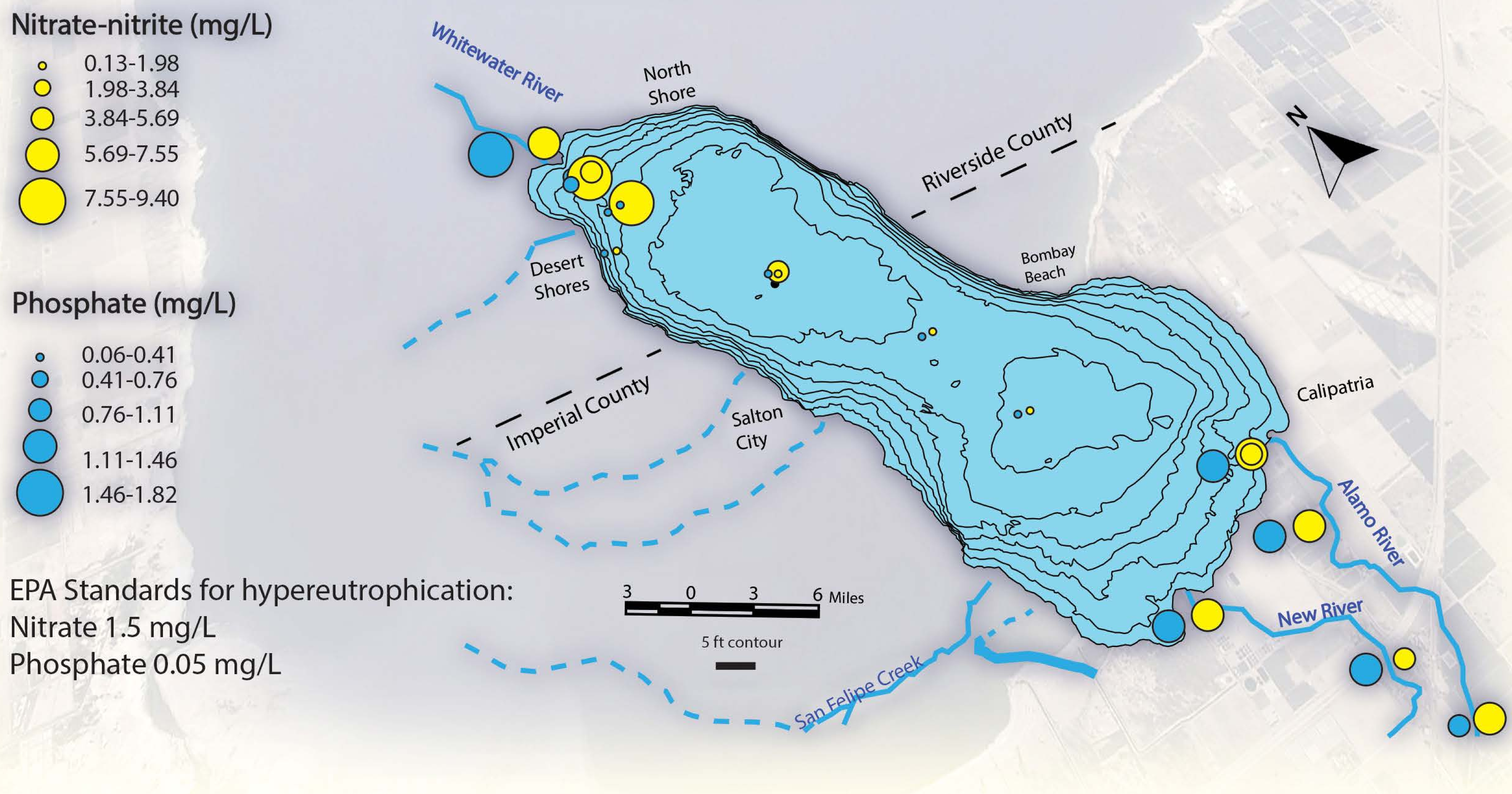
1924 and 1928: President Coolidge implemented Public Water Reserve Orders 90 and 114, dedicating land under the Salton Sea to manage agricultural and stormwater runoff, effectively sustaining the lake.

1968: California legislature enacted Assembly Bill 461, officially designating the Salton Sea for agricultural drainage collection.

1970s: Salinity crosses 37, threshold for sustaing aquatic life. Bird and fish species now listed as locally endangered, and gradually, locally extinct.

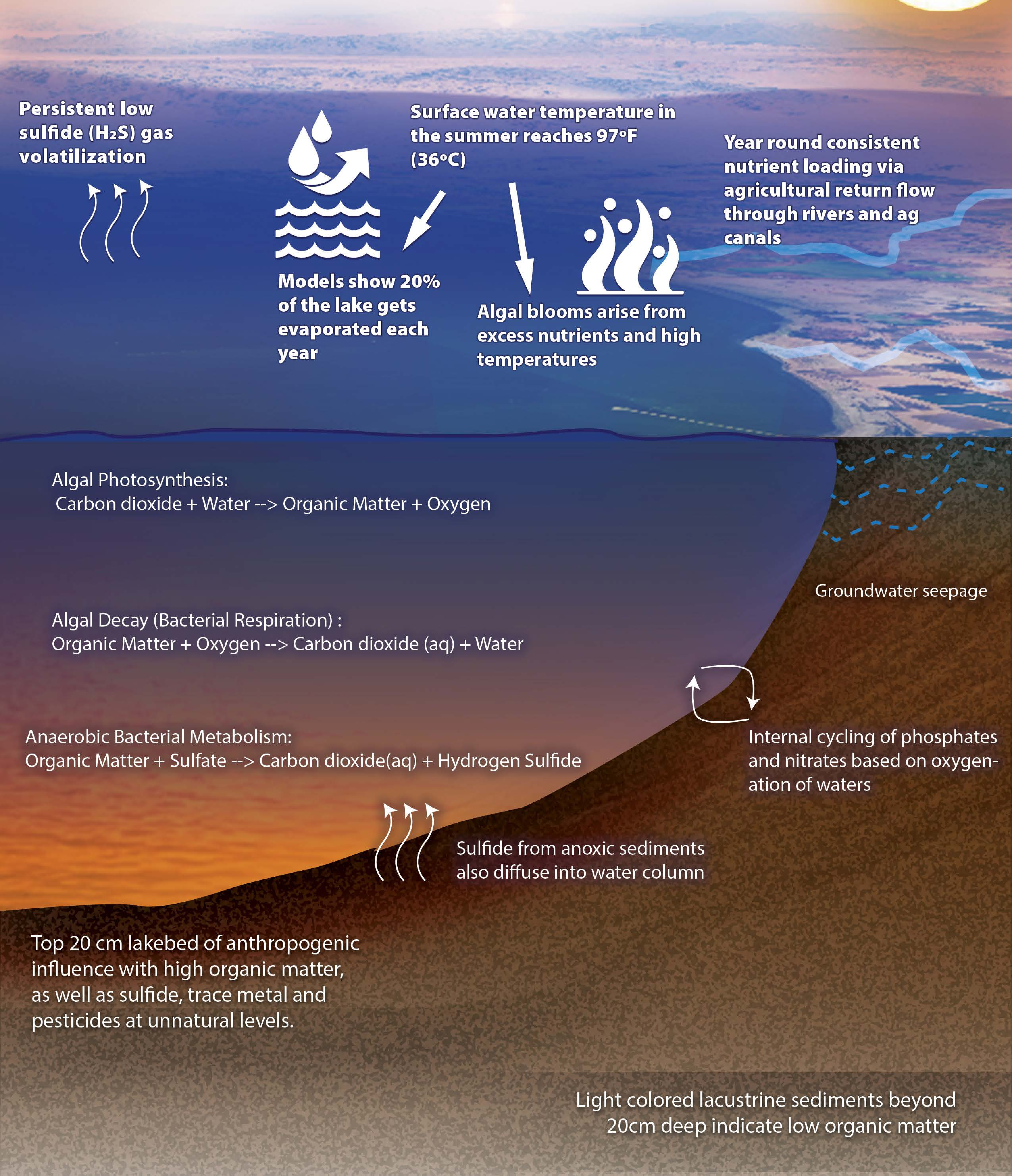
2003: Quantification Settlement Agreement executed to quantify IID, CVWD, and Metropolitan Water District's share of California's 4.4 million acre-feet of Colorado River water.

II. Spatial Map of Nutrient Inputs through Agricultural Runoff



EPA Standards for hypereutrophication:
Nitrate 1.5 mg/L
Phosphate 0.05 mg/L

III. Biogeochemical Cycling at the Salton Sea:
The Interconnected Air, Water and Sediment



IV. FAQs

Why is the Salton Sea so salty?

The Salton Sea is a terminal lake, meaning water flows in but doesn't flow out. Most of its water comes from the already salty Colorado River and agricultural runoff, which carries extra salts and nutrients fertilizer from flushing the fields. As the water evaporates in the hot climate, it leaves the salts and nutrients behind. Over time, these salts and nutrients build up, making the lake even saltier with compromised water quality due to eutrophication. In fact, sulfate salts in the Salton Sea are about seven times saltier than seawater, all due to this cycle of untreated input, evaporation and salt accumulation.

What causes the rotten egg yolk smell?

The rotten egg smell around the Salton Sea comes from high sulfide concentrations in the water. Extra nutrients brought in by agricultural return flow causes algae overgrowth. When algae blooms die off, their decay consume oxygen, allowing bacteria that thrive without oxygen to dominate. These bacteria convert sulfate (highly available salts, as mentioned above) to sulfide. As sulfide concentrations increase, some of it turns into sulfidic gas, which has that distinctive rotten egg odor. Our findings indicate that as the lake becomes shallower and mixes more, sulfide levels in the water vary, leading to the gas being released more frequently but in lesser amounts.

Why can't fish persist in the lake?

The Salton Sea's extremely high salinity and poor water quality makes it inhospitable for fish. In the late 1900s, mass die-off events occured due to a lack of oxygen and toxic sulfide buildup in the water. Although the California Department of Fish and Game introduced various fish species in the 1950s, such as corvina and tilapia, the harsh conditions and absence of native fish species have largely prevented fish populations from persisting in the lake.

What would be helpful in terms of water monitoring?

Monitoring the Salton Sea is essential as it faces constant changes. The reduction in government monitoring, due to the lake's shallowing and accessibility issues, creates a gap in understanding its dynamics, crucial for its ecological health and risk mitigation. Deploying remote buoys with sensors for real-time, continuous data on water quality can provide vital insights into the lake's rapidly changing conditions, including the expansion of suboxic zones and altered sulfide release patterns, which shifted from sporadic, high-volume events to more fequent, lower-volume ones. These shifts have major implications for wildlife and public health. Transmitting this data via cellular networks ensures public access, fostering transparency and swift action. Encouraging community science can also keep the monitoring ongoing despite challenges. Up-to-date information is key to informed decisions for the lake's management and conservation.

Why should we care about cleaning up the Salton Sea lake water?

Firstly, aerosals or sea spray from the lake water or playa dust can carry microbial toxins, which poses a significant health risk to nearby communities. Secondly, the lake's persistently low oxygen levels and sulfidic conditions create a hostile environment for aquatic life, disrupting the ecological balance and restoration efforts. Additionally, these environmental issues directly impact the quality of life for local communities, potentially exacerbating health problems and diminishing the area's livability. Finally, with the emerging ithium industry around the Sea, improving water quality becomes even more essential. The introduction of a new workforce and the development of this industry depend on a safe, healthy environment. Addressing water quality issues is not just about protecting ecosystems but also about ensuring the well-being and economic future of the region.

LYONS BIOGEOCHEMISTRY LAB

Tim Lyons

Distinguished Professor of Biogeochemistry/ Principal Investigator

timothyl@ucr.edu

Charlie Diamond

Academic Coordinator/ Postdoc

Trace metal and Analytics

cdiam001@ucr.edu

Caroline Hung

PhD Candidate

Nutrients and Sulfur Cycle

chung041@ucr.edu