Determining the Presence and Concentrations of EPA Semi-Volatile Organic Compounds in the Colorado River

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INTRODUCTION

Rachel Carson's *Silent Spring* (1962) sparked public discussion on the harmful effects to ecosystems and humans from the misuse of pesticides. By the 1970s the Environmental Protection Agency (EPA) began recommending regular monitoring for pesticides in ground and surface water, and Congress enacted the Safe Drinking Water Act (SDWA) in 1974. Since then pesticides have proven to cause a variety of adverse health effects in non-target organisms.

Due to Timberlake Biological Field Station's proximity to the Colorado River, we focused our research on the surface water quality there and its safety for local aquatic species. Currently the EPA does not regulate pesticide concentrations in surface water, and there are no EPA aquatic-life criteria for herbicides.

Under the SDWA the EPA must establish and maintain a drinking water Contaminant Candidate List (CCL) of chemicals and microbes to consider for future regulation. It has since created its EPA Method 525.3 (an ampule of 44 CCL semi-volatile organic chemicals) for laboratories to simultaneously test for the presence of these SVOCs. Our experiment tested the water in the Colorado River near Timberlake BFS for these 44 SVOCs.

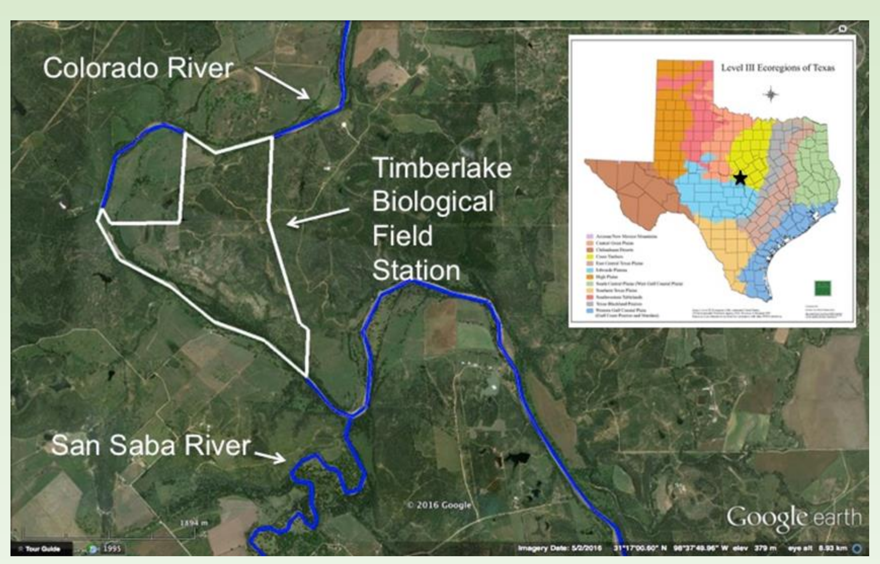


Fig. 1 – Aerial view of Timberlake Biological Field Station and the Colorado River

OBJECTIVES

The objective of this study was to:

1. Determine the presence of any of the 44 EPA Method 525.3 SVOC pesticides in the Colorado River adjacent to the Timberlake Biological Field Station;
2. Quantify the concentrations of these pesticides; and
3. Assess whether these concentrations present a threat to the local aquatic ecosystem.

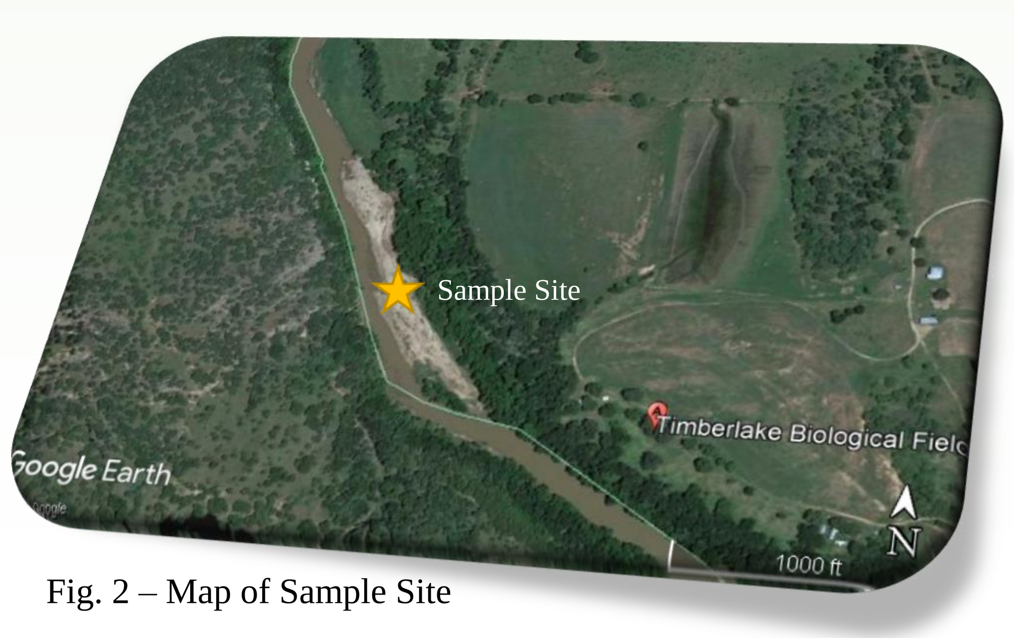


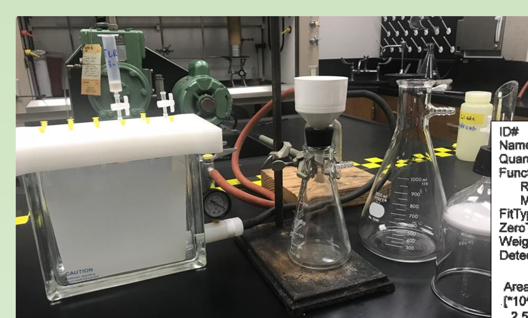
Fig. 2 – Map of Sample Site

METHODS

We collected grab water samples from the Colorado River adjacent to the Timberlake Biological Field Station in Mills County, Texas. Using a gas chromatograph, we compared the GC results of the water samples to the GC results of the prepared EPA standards to determine the presence of pesticides in the water.

Dilution of Standards:

1. Transfer 1 mL ampule of EPA standards to 5 mL volumetric flask. Dilute to volume.
2. Use Pasteur pipette to transfer 1.5 mL of diluted standard into autosampler vial.
3. Re-dilute volumetric flask to volume.
4. Repeat steps 2-3 to create a total of 4 autosampler vials.
5. Run autosampler vials in GC using below method.



Picture 1 – Vacuum apparatus and filters

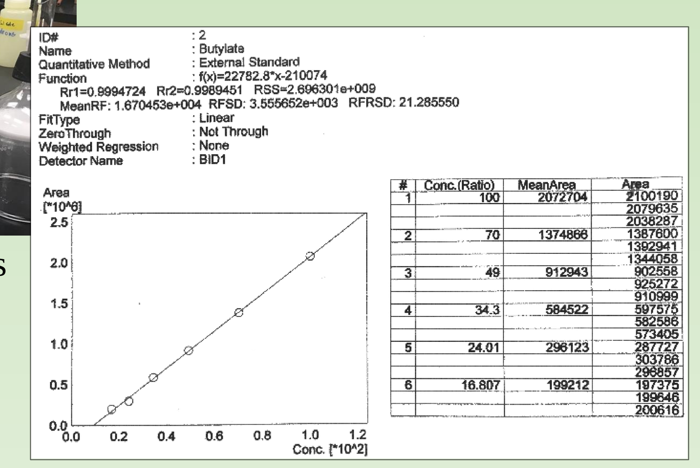


Fig. 3 – Calibration curve for Butylate

Gas Chromatograph Method:

1. Begin with initial temperature of 70°C.
2. Ramp temperature up by 10°C per minute until 200°C.
3. Ramp temperature up by 7°C per minute until 320°C at 30 psi. Hold for 3 minutes. Inject sample at 270°C
4. Begin data acquisition at 7 minutes.

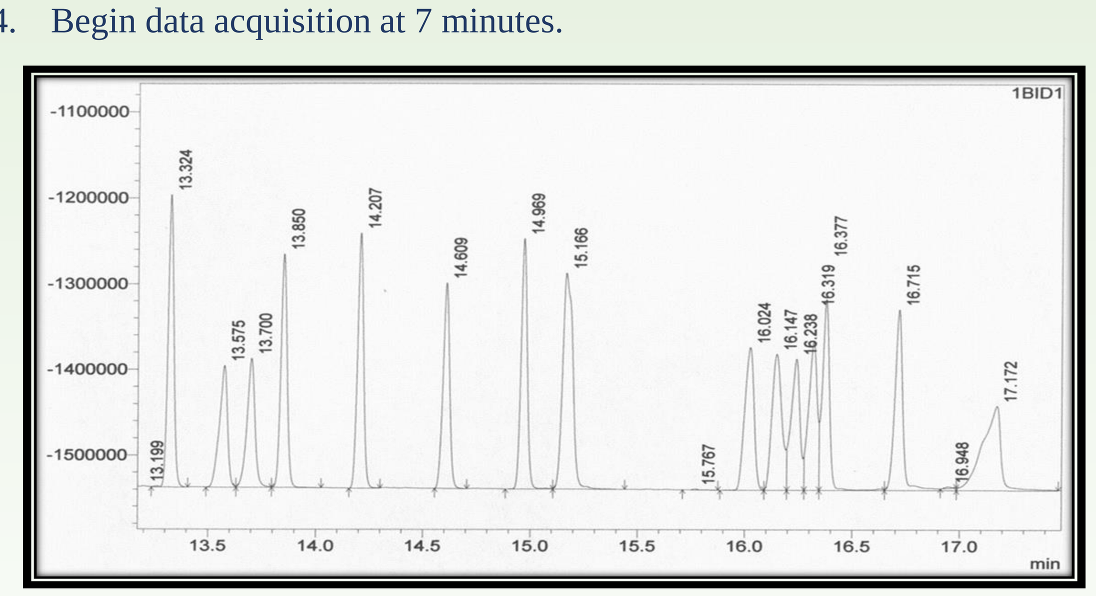


Fig. 4 – Close-up of Chromatograph of Method 525.3 Standards

Sample Preparation:

1. Filter river water sample with Büchner filter and fritted filter.
2. Bring water sample to pH of 4 with 3% phosphoric acid.
3. Measure 1 L water sample in volumetric flask.
4. Set up vacuum apparatus with single-use SPE cartridge.
5. Condition cartridge with 5 mL ethyl acetate and 10 mL 5% methanol. Rinse cartridge with 10 mL ultra pure water.
6. Run water sample through cartridge. Rinse with 10 mL ultra pure water. Dry by vacuum 10 minutes.
7. Elute cartridge into 15 mL test tube with 5 mL ethyl acetate and 5 mL dichloromethane.
8. Concentrate eluted sample with nitrogen gas and warm water bath until less than 1 mL.
9. Transfer concentrated sample into autosampler vial and bring to final volume of 1.5 mL with ethyl acetate.

RESULTS

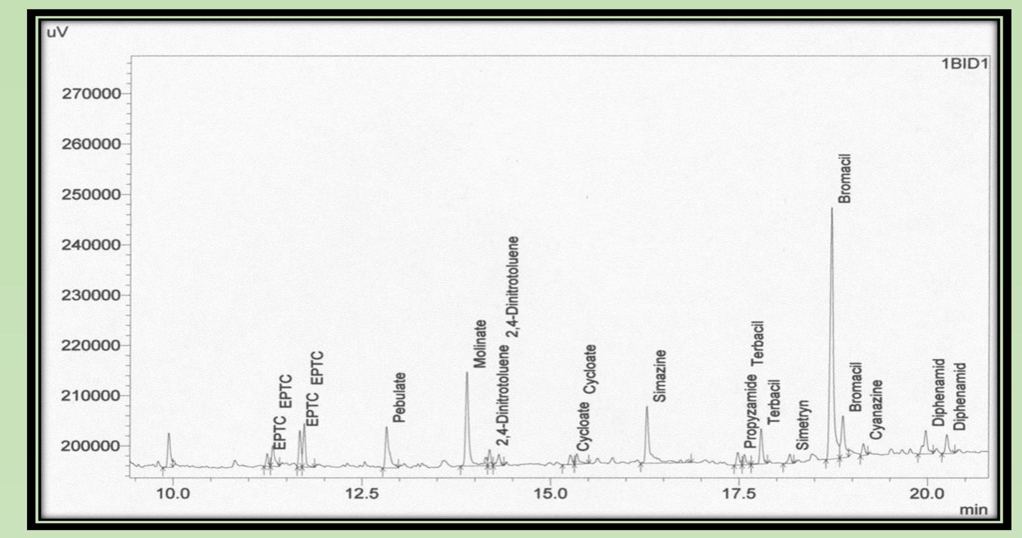
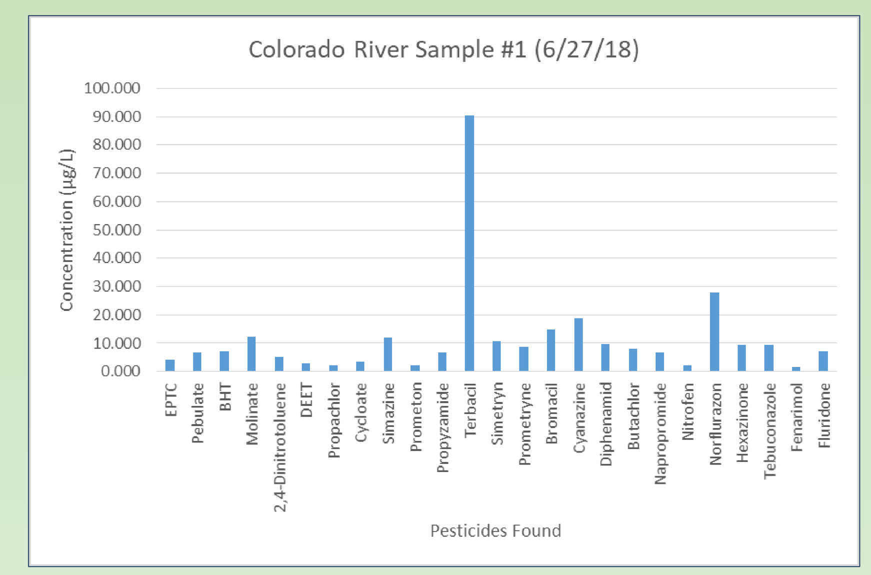
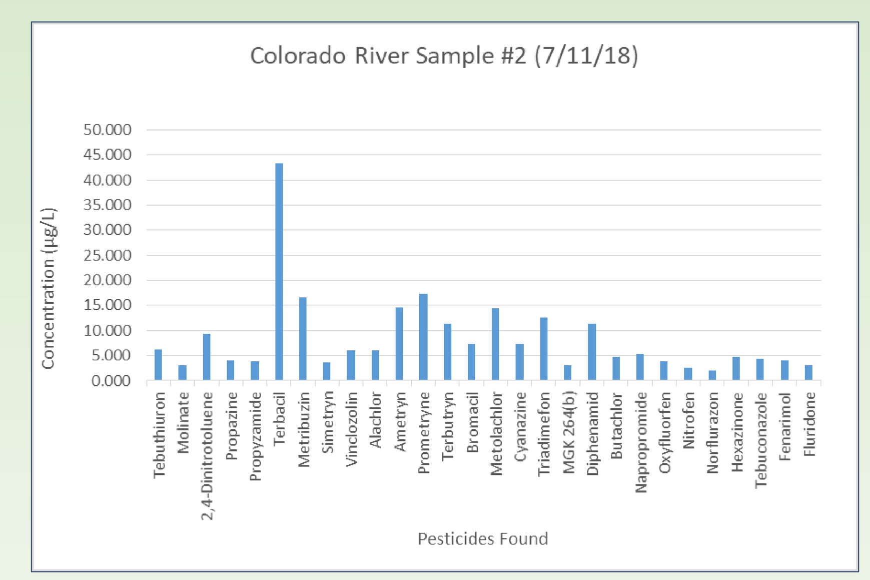
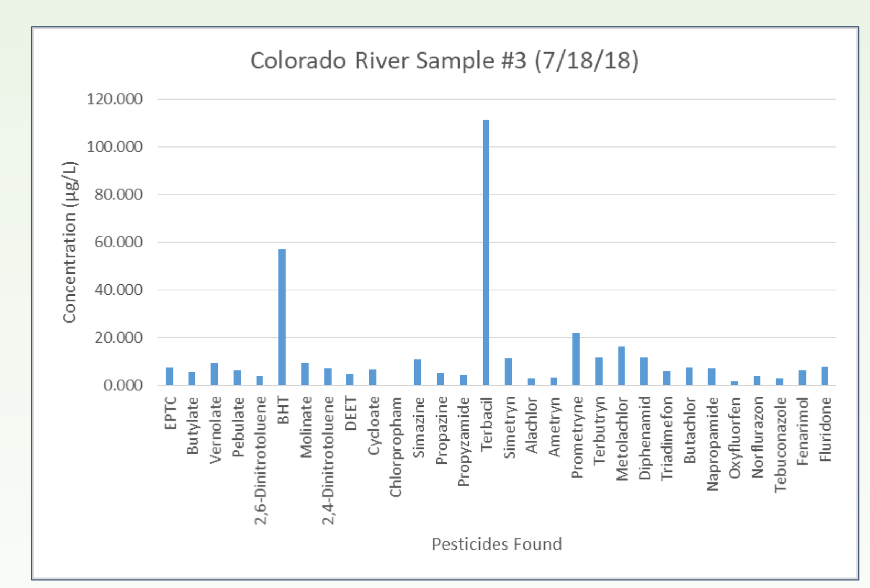


Fig. 5 – Close-up of water sample chromatograph results







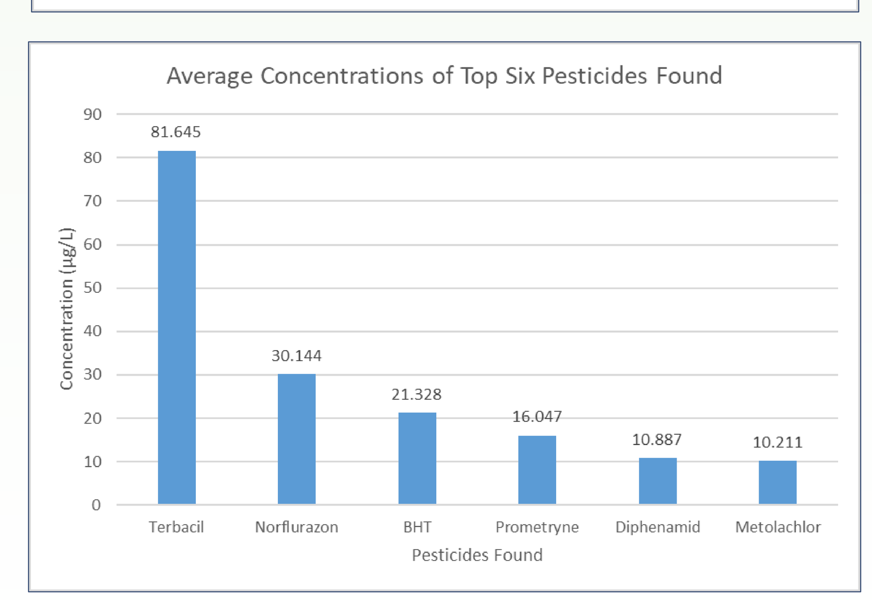


Fig. 6 – Bar graphs of concentrations of pesticides found in the Colorado River

SUMMARY OF RESULTS

Our data indicates that SVOCs are present in the Colorado River near Timberlake Biological Field Station at low concentrations (micrograms/liter). The six pesticides with the highest concentrations over our period of study were, in order of increasing concentration, Metolachlor, Diphenamid, Prometryne, BHT, and Terbacil. These were found at concentrations in µg/L of 10.211, 10.887, 16.047, 21.328, and 81.645 respectively.

CONCLUSIONS

The higher concentrations of these pesticides in our water samples are not surprising. All six pesticides are herbicides. Our water samples were taken from a part of the Colorado River downstream from several pecan orchards. Out of all the pesticides for which we tested, Terbacil consistently had the highest concentration in our samples. Terbacil is a selective herbicide commonly used to control grasses and weeds in pecan farming.

Above – Colorado River near Timberlake Field Station (from TSU REU website)
Right – Collecting water samples

Terbacil has a very slow biodegradation rate, is not susceptible to hydrolysis or volatilization, and has a very high mobility in water. However, at the concentrations we detected, Terbacil is unlikely to cause harm to the local ecosystem. In terrestrial organisms it is practically non-toxic, and it is only slightly toxic to marine organisms. In order for Terbacil to present a threat to Timberlake's aquatic organisms, its concentration would need to be at least 5 mg/L.

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