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Per- and Polyfluoroalkyl Substances: A Preliminary Evaluation of Groundwater Contamination in the Western States

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Carter Daniel Johnson

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Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

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Author: Carter Johnson
School: Reykjavik University
Mentor: Mark Verdoorn, David Twamley
Organization: Environmental Support and Services

Introduction

Per- and Polyfluoroalkyl Substances (PFAS) are a manufactured group of chemicals that have been used since the 1940s. PFAS break down very slowly and studies show that exposure to these chemicals may cause negative reproductive effects, developmental delays in children, increased risk of some cancers, and interference with the body's natural hormones.

On June 15, 2022, EPA issued interim updated drinking water health advisories for the two most widely studied PFAS, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). The concentrations for the health advisory limits are 0.004 parts per trillion (ppt) and 0.02 ppt respectively. Because data is often reported in combined PFOA and PFOS concentrations, and for ease of data visualization, concentrations of the two chemicals will be discussed as a single, summed value and will be compared to the combined health advisory limits of 0.024 ppt. Due to the recently published near-zero health advisory limits and the known negative health effects, a map of estimated PFAS groundwater contamination will be useful in informing the public and determining which regions are most at-risk.

Methods

Groundwater data for PFOA and PFOS were acquired through the Environmental Working Group, georeferenced using ArcGIS Pro, and layered on top of major aquifer boundaries retrieved from the ESRI Portal (Figure 2). Once the data was compiled, the scope of the project was determined. Time constraints prompted an analysis of just the western states and a "select by location" tool helped to sort out the aquifers with useful contamination data from ones with too little data to analyze. Next, the geostatistical tool "IDW" was used to interpolate the concentration data. This tool works by predicting values using a weighted distance average and is well-suited for large input datasets such as this. The model builder tool (Figure 3) was used to run multiple "IDW" tools at once. Each "IDW" received concentration data and aquifer polygons as input. Constraining the analysis with individual aquifer boundaries helped to recreate realistic groundwater behavior, as contamination from one aquifer will generally not travel to affect concentrations in another. Last, to easily visualize the data, each of the nine output rasters were edited as one with the "batch apply symbology" tool to produce the results shown in Figure 1.

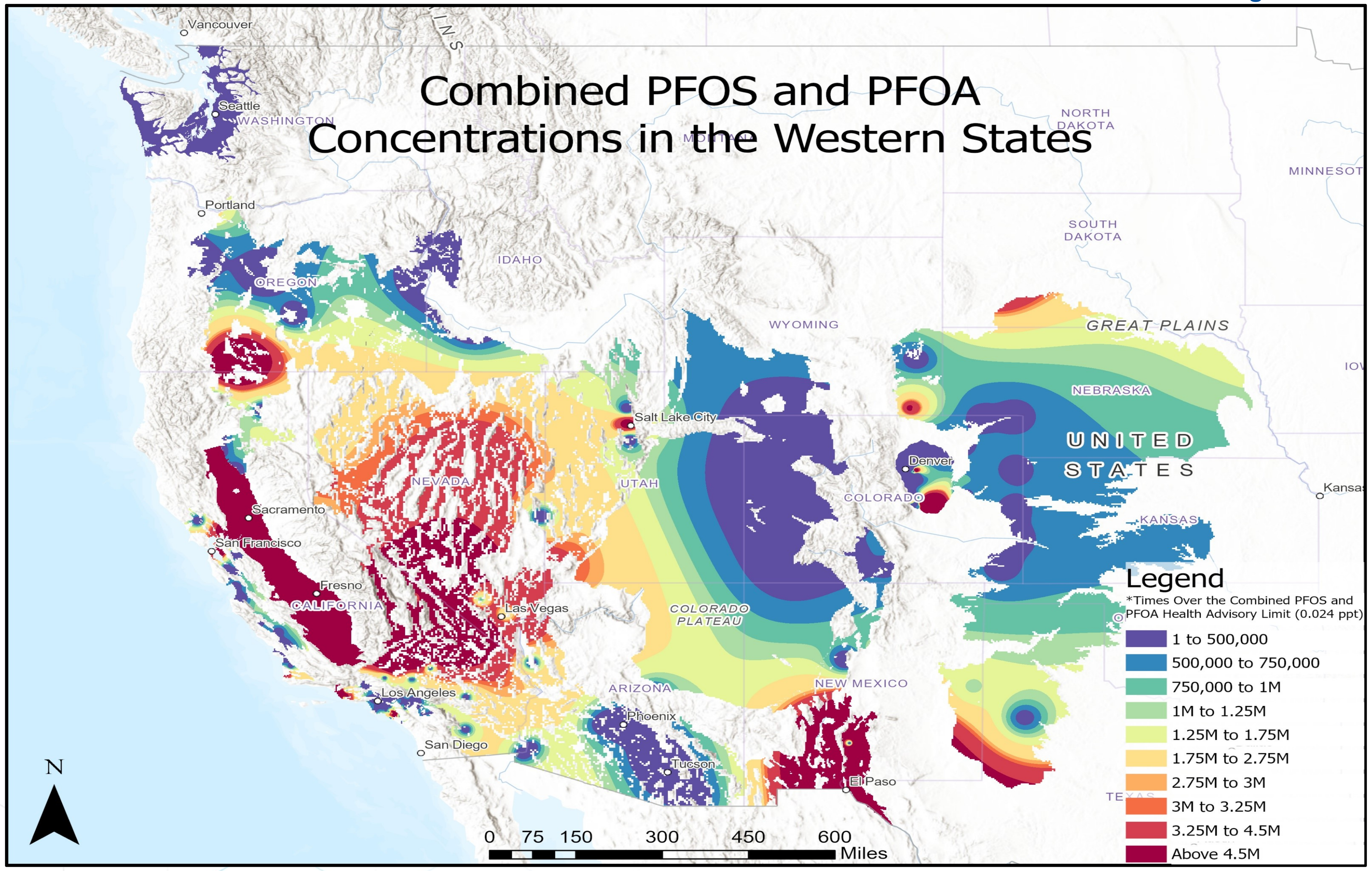

Figure 1. Results of the study and the output of the analytical model below. Concentrations were converted to times over the combined health advisory limit because there are virtually no discernable areas below the health advisory limit on a map of this scale. Produced by ArcGIS Pro

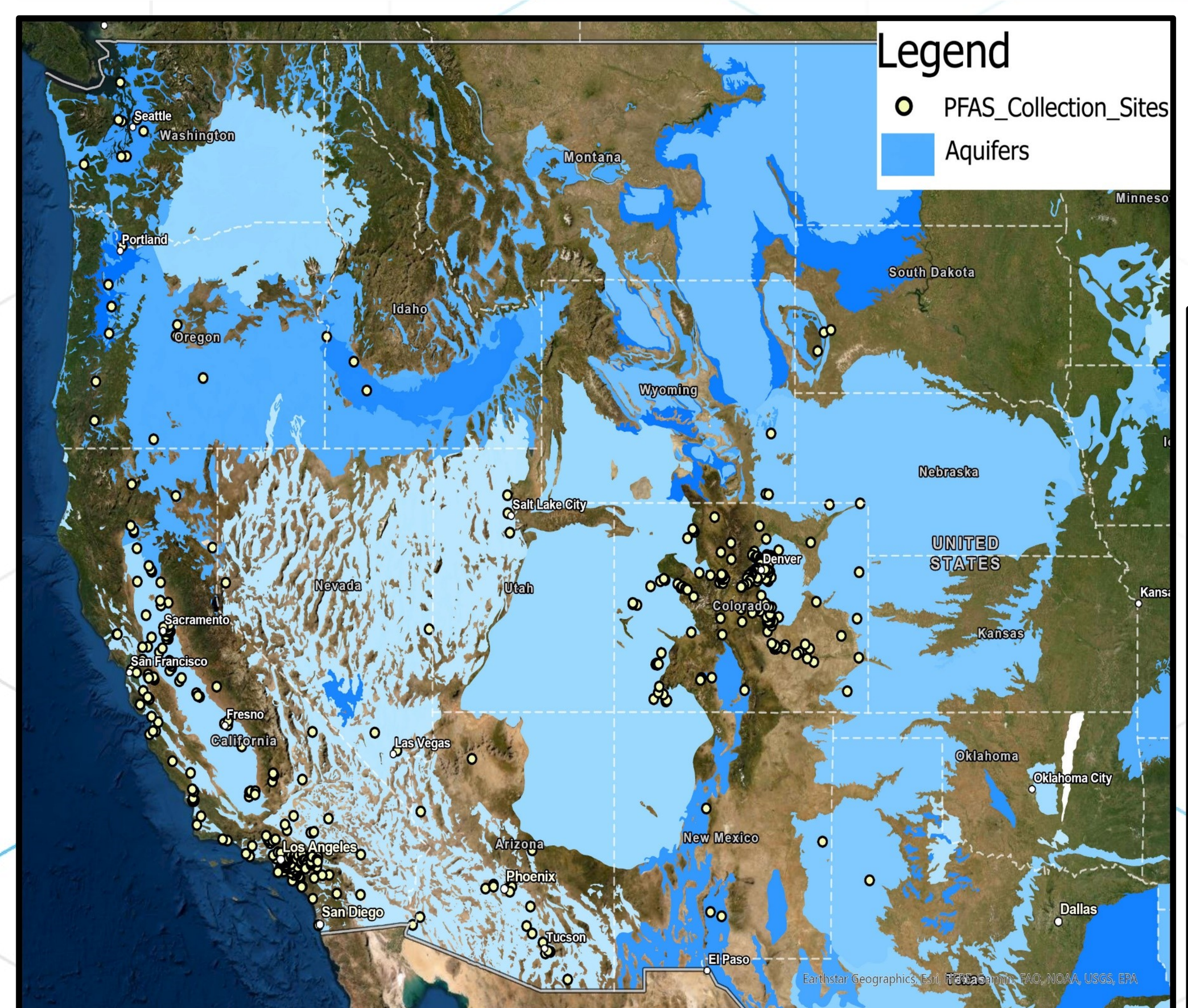

Figure 2. Georeferenced concentration data points overlayed on major aquifer boundaries

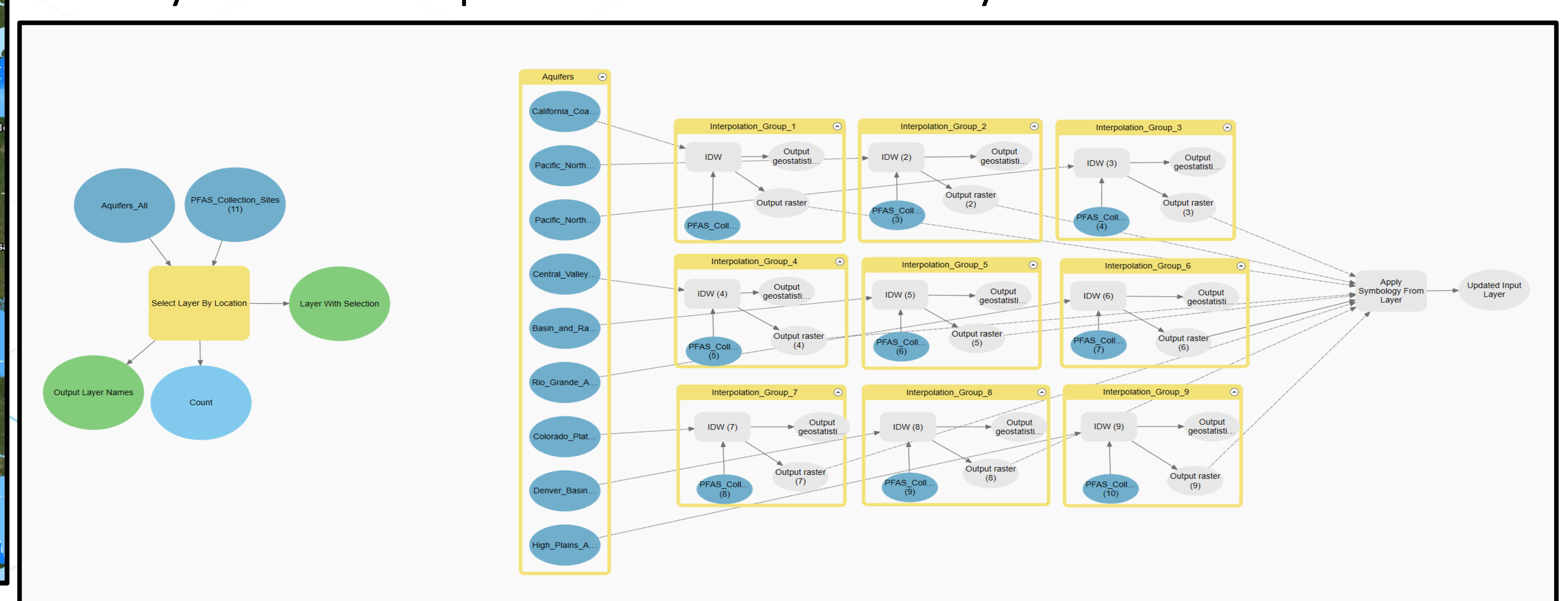

Figure 3. The model used to convert limited concentration data into an uninterrupted, interpolated map of estimated PFAS contamination

Conclusion

As detailed in Figure 1, the analysis suggests that there are very few areas in major aquifers where PFAS concentrations exist under the health advisory limits. Additionally, there exists large areas of groundwater that contain PFAS concentrations millions of times over the limits. Although more samples would greatly increase the accuracy of this figure, it does demonstrate the magnitude of our risk of exposure to PFAS through drinking water.