

Analysis of Chemical Parameters in an Anthropogenic Depression in Bass River

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Abstract: An analysis of chemical parameters in a 12 m deep anthropogenic depression in Bass River was performed. Our data indicate a continuous increase in salinity with depth starting from 15 ppt at the surface continuing to 21 ppt at the bottom. The water column exhibits continuously decreasing dissolved oxygen concentrations, becoming anoxic below 7 m. Redox potential values show a similar drop, becoming negative soon after the onset of anoxia. These negative values indicate reduction of sulfate, which was verified by a drop in the sulfate concentration at deeper depths. The concentrations of silica, phosphate, and total alkalinity show a significant increase toward the bottom of the water column. Correlations of all these parameters to each other had coefficients of 0.80 or higher. This suggests the same source of these chemical species, which is likely sand and decomposition of organic matter, both coming from the sediments. Fluxes of these chemical species into the water column give this basin a distinct chemical signature.

Introduction and Background: The Great Bay estuary is one of the few pristine estuaries in NJ, with a primarily freshwater influence. The anthropogenic depression used in this study (Figure 1) was created during the construction of the Garden State Parkway in the 1950s. Material was drawn out of the basin, located next to Bass River, to use as filler for the roadway, creating a deep pit. The mouth of the basin that connects to the Bass River is very shallow (<0.75 m) and narrow (7 m across). This results in little water exchange with the semi-diurnal tide cycle experienced by the river. The limited water flushing results in a highly stratified water column. In addition, the basin sits approximately 120 m east of the parkway and is likely subject to significant chemical runoff, which may affect water quality.

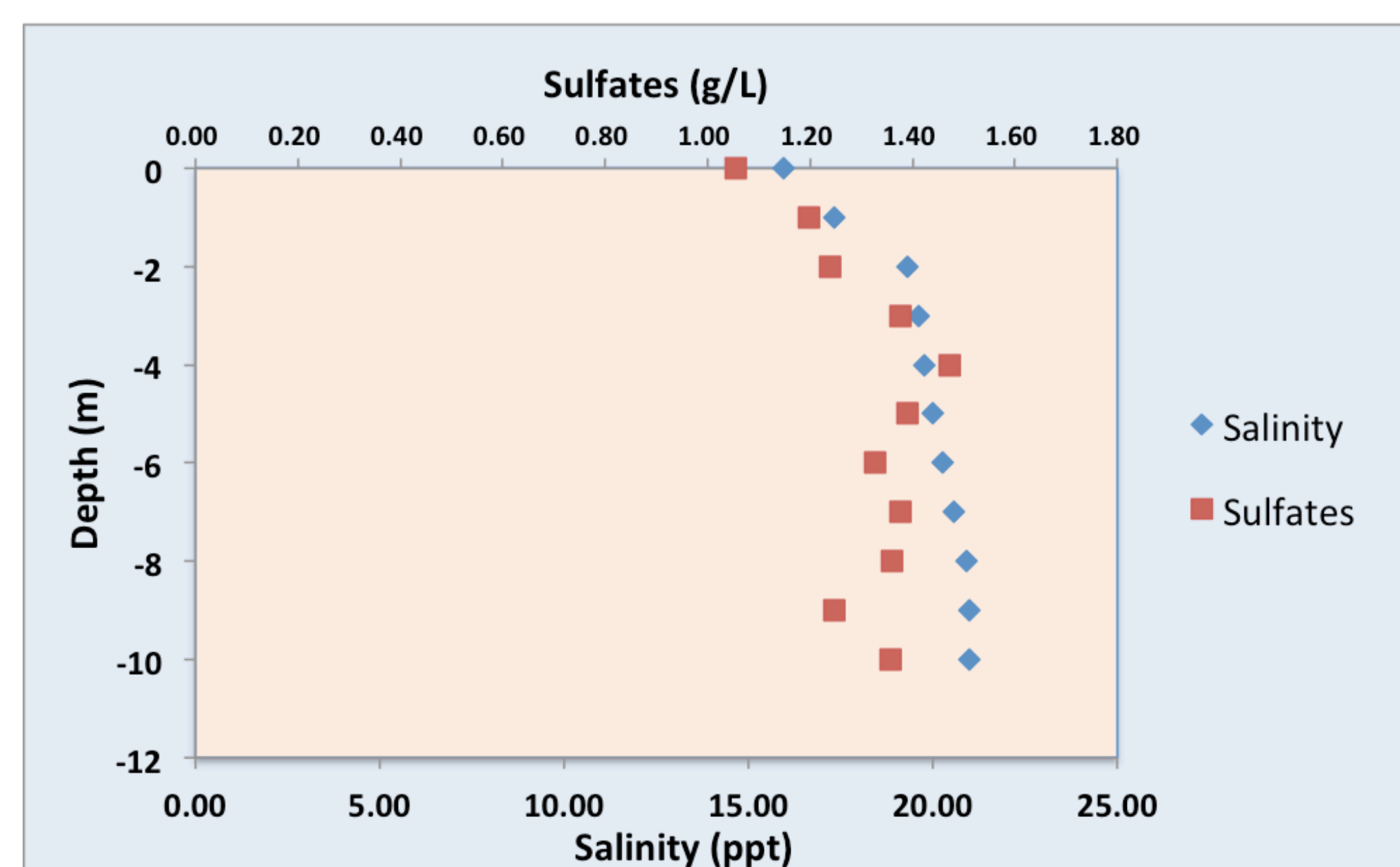


Figure 2: Salinity and sulfate vs. depth.

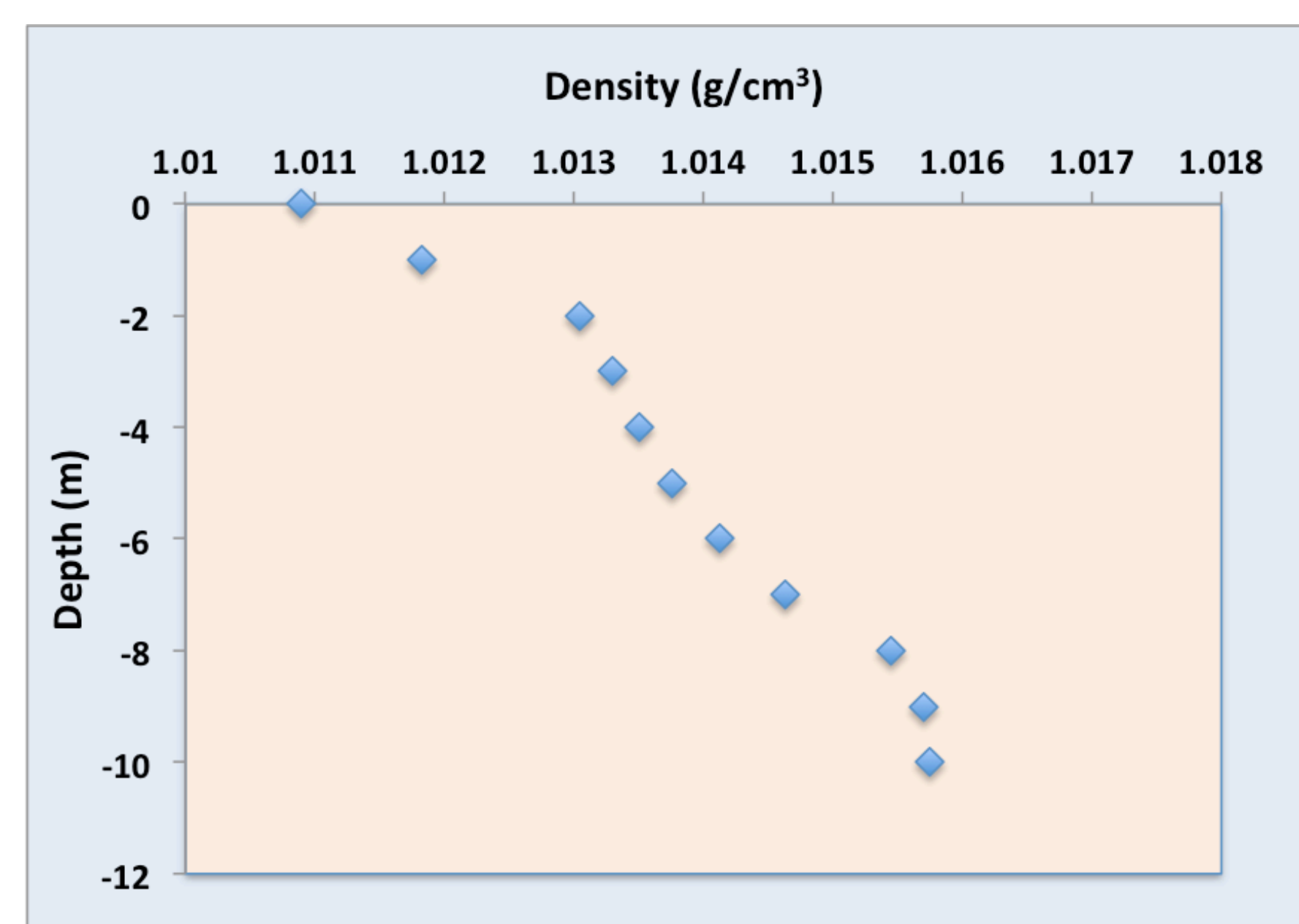


Figure 3: Vertical density profile.

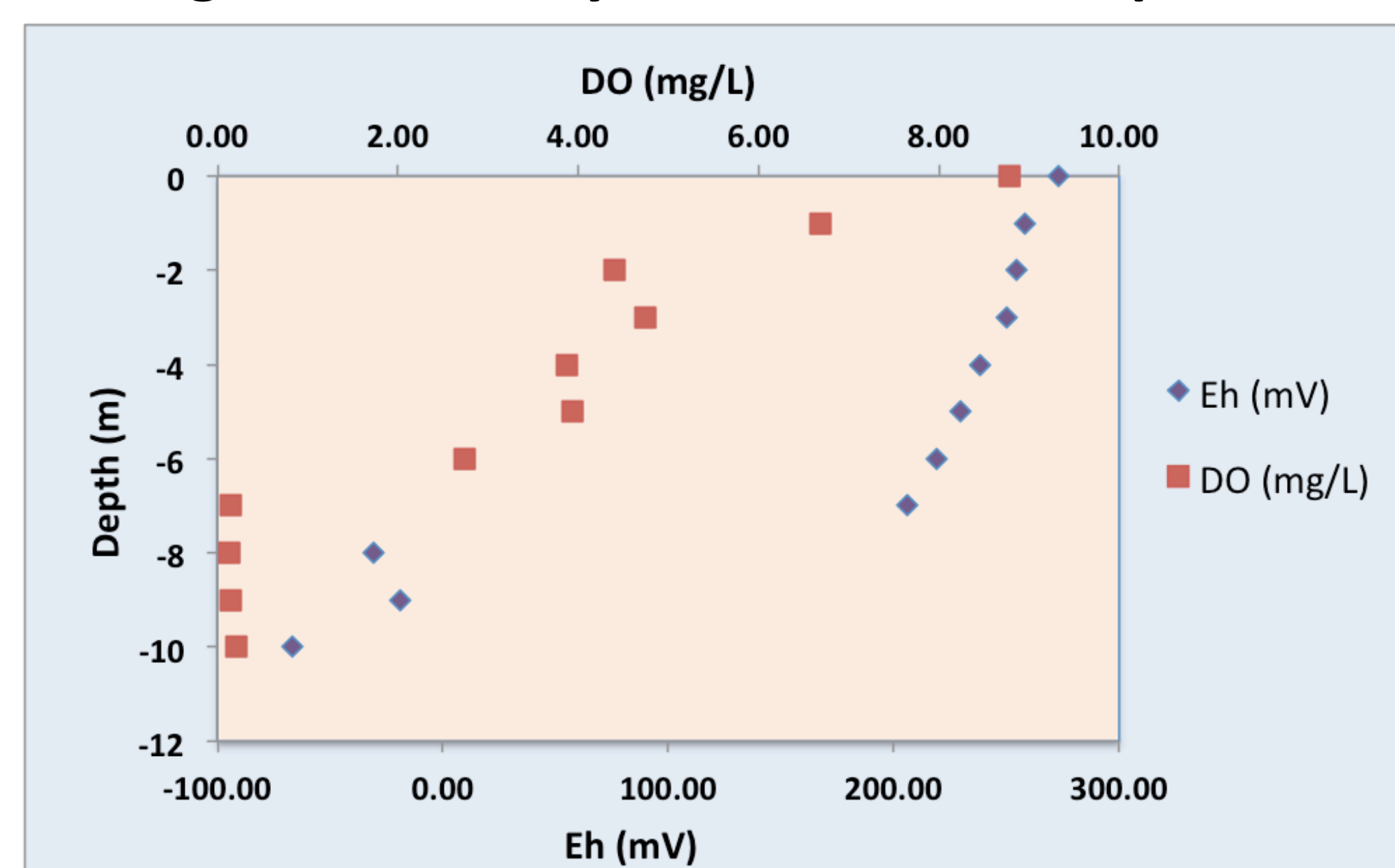


Figure 4: Dissolved oxygen and redox potential (Eh) vs. depth.

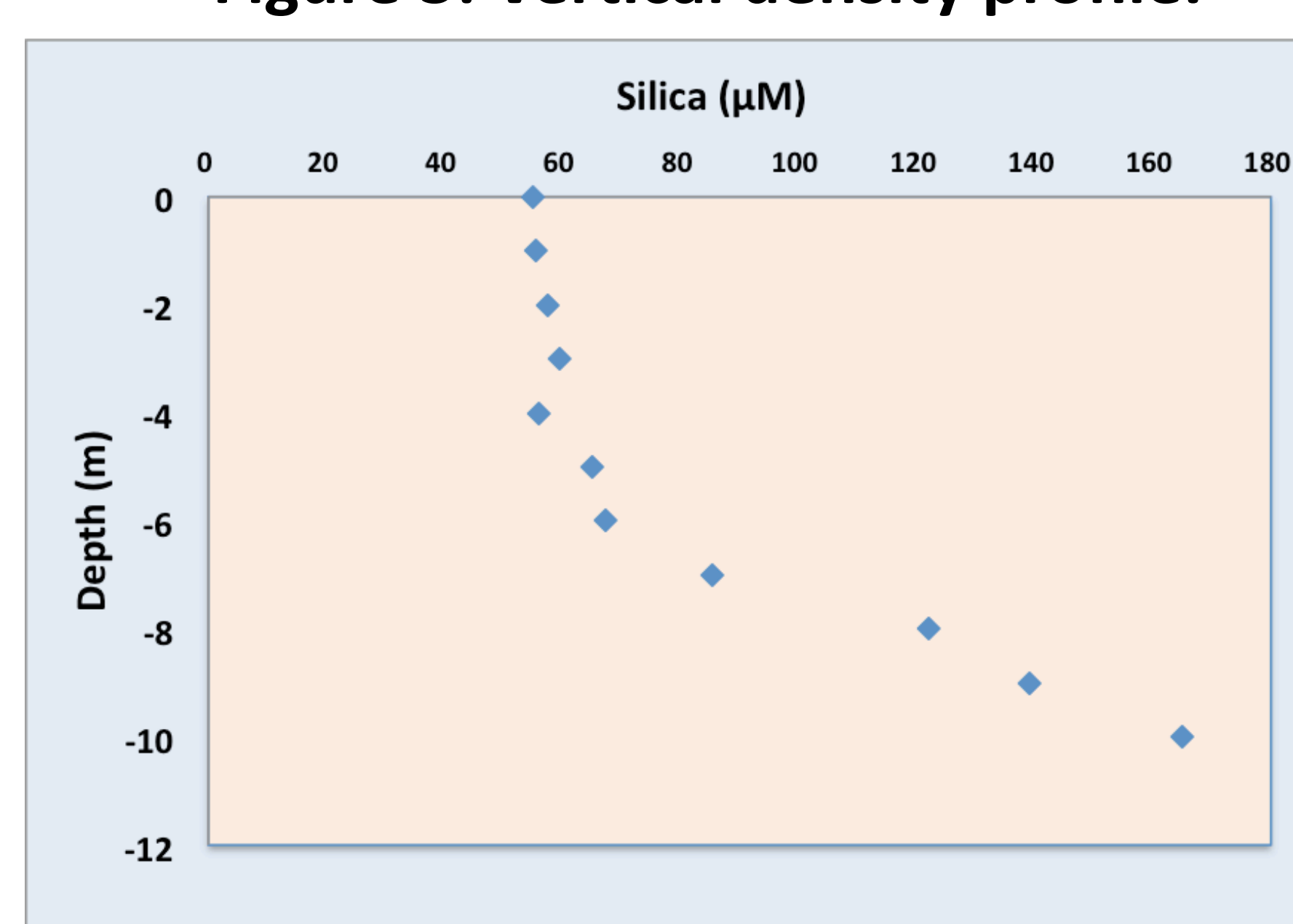


Figure 5: Vertical profile of dissolved silica.

Results and Conclusions:

As depth increases to 4 m, sulfate increases from 1.05 g/L to 1.5 g/L (Figure 2), having a maximum value at salinity of 20 ppt. In the top 4 m, sulfate concentration parallels that of overall salinity. Below this depth, sulfate concentrations do not follow overall salinity, which continues to increase, albeit at a slower rate. Decreasing sulfate concentrations are likely due to the chemical reduction of sulfate to sulfide. Density change in the water column is very pronounced (Figure 3), with sigma values varying from 10.9 at the surface to 15.7 at 12 m. This strong pycnocline is the result mainly of a pronounced halocline, but also of a thermocline.

Surface dissolved oxygen levels are high (9 mg/L) due to the mixing of O₂ from the atmosphere (Figure 4). As depth increases, the water column exhibits a continuous decrease in dissolved oxygen concentrations, becoming anoxic below 7 m. Redox potential and dissolved oxygen concentrations are proportional to each other. Therefore, increasing depth results in a decrease in both dissolved oxygen and the redox potential. Once anoxic conditions are established (between 7 and 8 m), the redox potential quickly shifts to negative values, from 205.7 mV to -30 mV.

Silica values are consistent from the surface to a depth of 4 m (Figure 5). As depth continues to increase below 4 m, silica concentrations begin to increase, most likely due to leaching of silica from sand found in sediments.

Remineralization/decomposition of organic matter in sediments introduces inorganic carbon and phosphorus into the water column. Inorganic carbon, in the form of bicarbonate (HCO₃⁻), is present and can be seen in our total alkalinity (TA) values. Inorganic phosphorus is present as phosphate (PO₄). The exact source of silica (abiotic leaching from sand) is somewhat different than that for carbon and phosphorus. However, its location—sediments—is the same as the source of the other two elements. The resulting strong correlation among these three parameters is shown in figures 6 and 7. All of the correlation coefficients among the three parameters were 0.8 or higher.

Correlation of different chemical species:

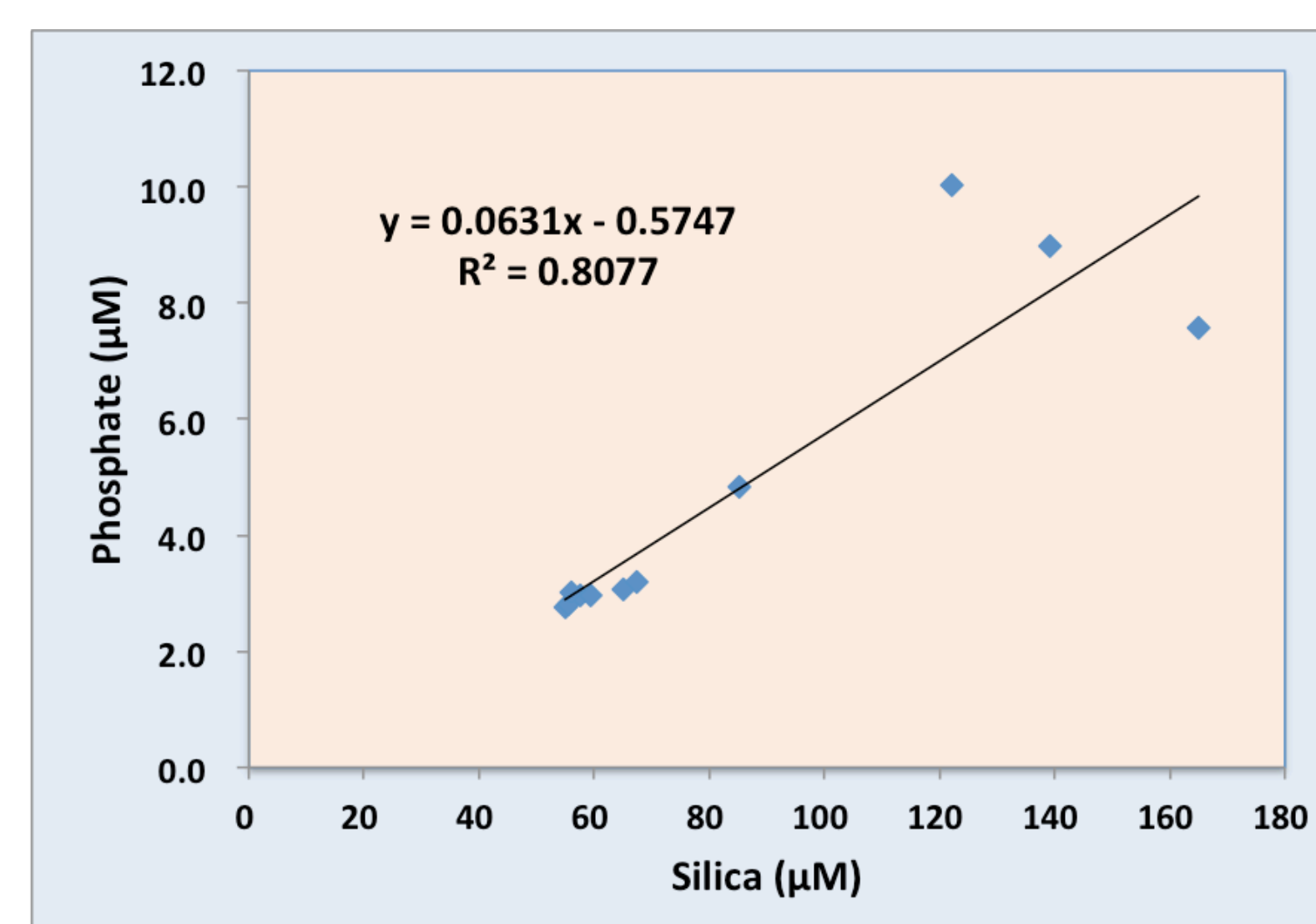


Figure 6: Correlation between silica and phosphate.

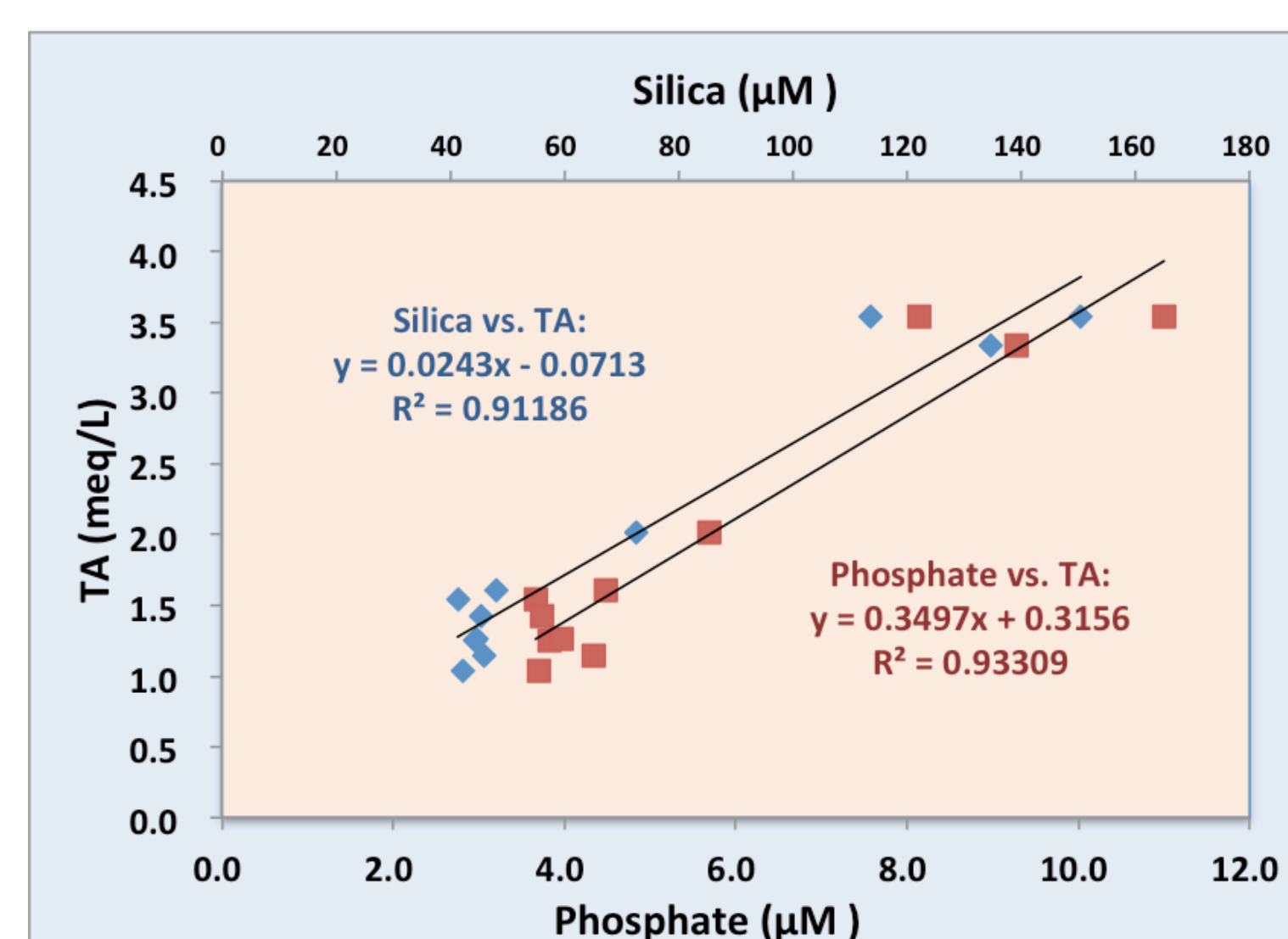


Figure 7: Correlation between phosphate, silica, and total alkalinity.

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Figure 1: Map of Mullica River-Great Bay Estuary.