Wickford Tide Gauge: First few months of data collection

The US Geological Survey (USGS) has deployed a tide gauge in Wickford Harbor for an entire year and readily has the data available to the public (https://waterdata.usgs.gov/nwis/uv?site_no=413413071270400&legacy=1). The role of this gauge is to continuously record the water level. Recording the level every ten minutes, these continuous measurements will be valuable for improving our understanding of Wickford Harbor's general hydrodynamics, navigation, and the potential local impacts of sea level rise over time. Below we have some data analytics of the first few months. Starting with the general time series in plot below.

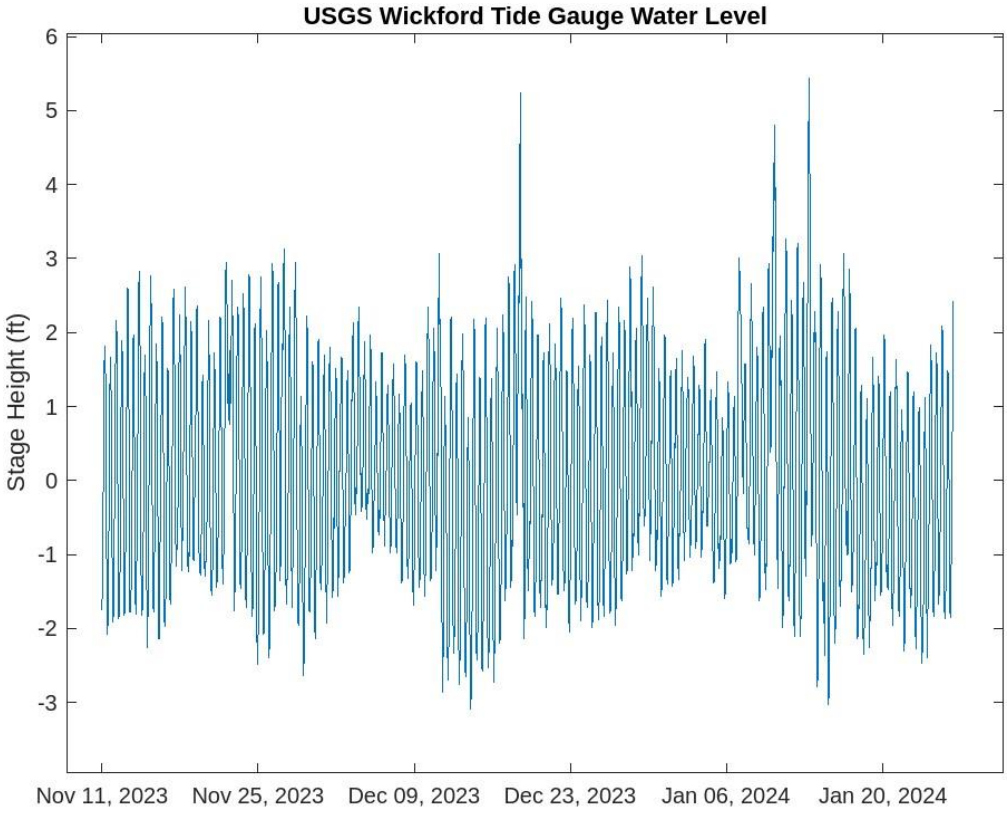

Figure 1: Water Level Data Collected by USGS in Wickford Harbor

Tidal signal is predictable for the most part. As stated on the NOAA website, "Tides are long waves that move across the oceans. They are caused by the gravitational forces exerted on the earth by the moon, and to a lesser extent, the sun." Throughout New England, we have two high and two low tides per day in relation to our area of latitude. By having the tide gauge in Wickford Harbor, we get a detailed picture of the water level variability. The tidal signal inside Narragansett Bay is slightly different from the open ocean because the tidal signal gets more attenuated or confined as you move more into the bay. During a high tide for instance, the open ocean level goes up, then the tide flows into Narragansett Bay and then into a sub-embayment like Wickford Harbor. The further you get from the open ocean and into more protected areas,

the less tidal signal you will see. This information can play a large role in understanding a variety of estuarine dynamics.

The NOAA website is a great resource for details (https://tidesandcurrents.noaa.gov/about_harmonic_constituents.html), but tides are predictable because there are numerous known variables that come into play, primarily the earth, sun, and moon. Because they are so predictable, we can actually break down each tidal signal into a variety of parts or tidal constituents. Through using harmonic analysis on our own tidal data, we can break down the parts of the tide and extract the residual which is caused by a variety of things such as precipitation, storm surge, or river runoff. Using the Matlab functions in UTide created by Dan Codiga at the University of Rhode Island, we are able to calculate the tidal constituents of our time series so far and plotted the 'Tidal fit' over the original time series in Figure 2 and 3 (both of the entire time series and the time series zoomed in).

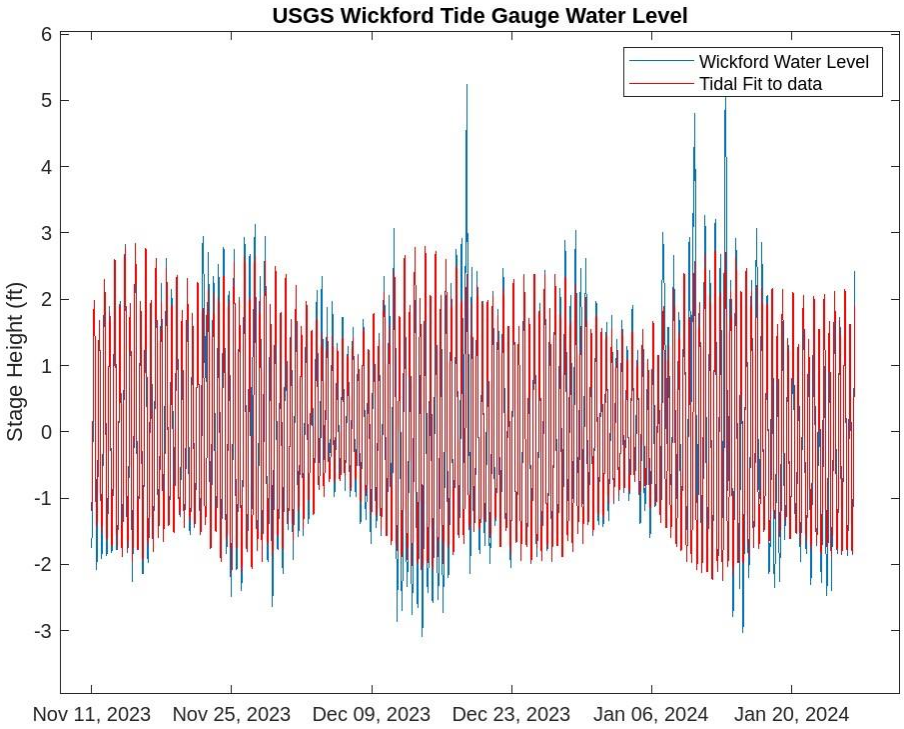

Figure 2: Water level data with the modeled tidal fit over the data in red.

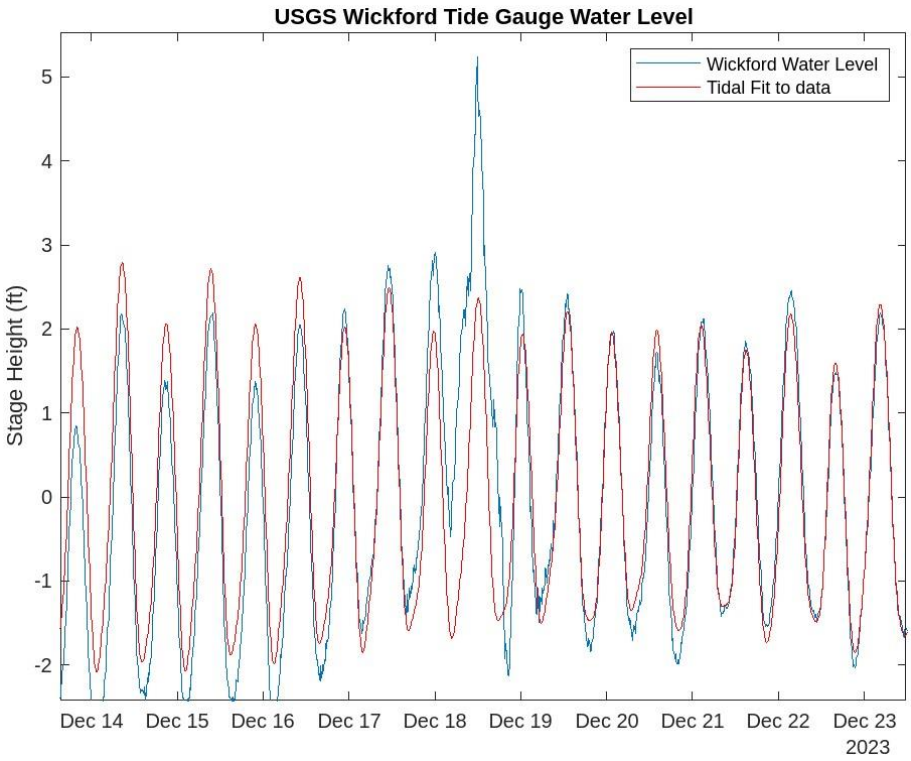

Figure 3: Time series with tidal fit December 13th through 23rd. Notice on December 18th how the large storm event heavily influenced the water level.

You probably notice from both Figure 2 and 3, there is more to water level than just tidal constituents. One great example of that is the large storm combined with a high tide on December 18th (Figure 3). An interesting note is when larger storms come into the area, we can see it directly in the water level data! When a storm is in the area, the wind from the storm pushes more water onshore. Combined with the increased freshwater inputs from the streams and runoff, this pushing of water results in an increased water level in those areas which can impact nearby coastal regions. This data will be useful for various types of planning for the town such as adapting and improving hazard mitigation strategies. Extracting the tidal signal from the USGS water level, you can see how many variables can influence the water level (Figure 4).

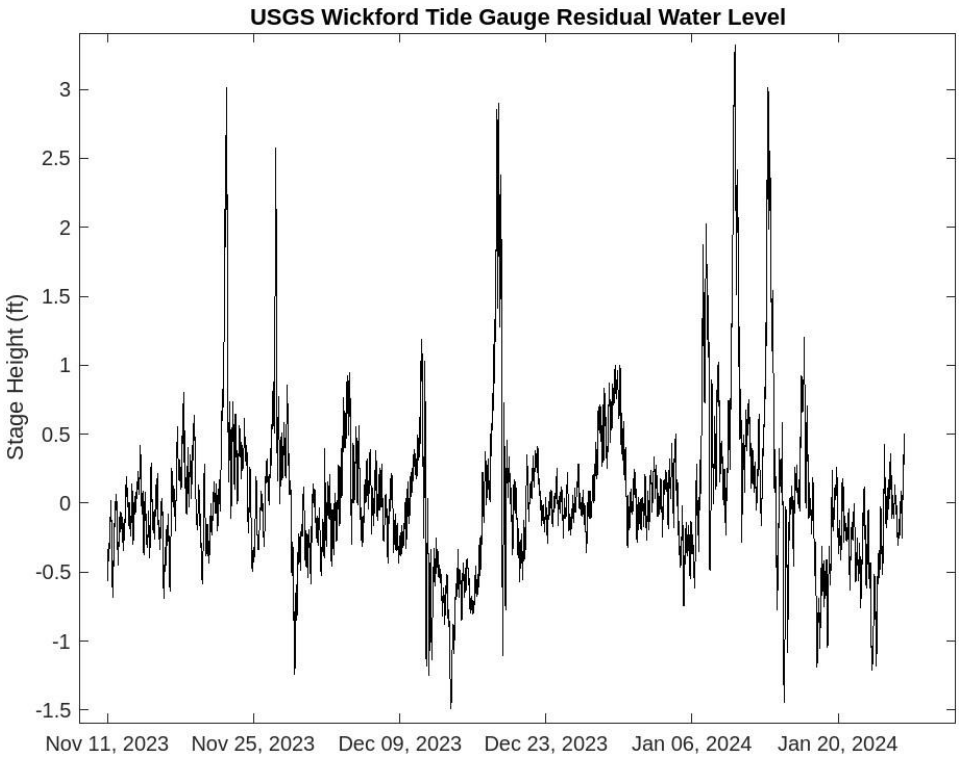

Figure 4: Residual water level (Water level with the tidal influence subtracted).

Tidal observations are taken regularly at Wickford Harbor, and you can visit the tide gauge if you are interested. There will be more data and figures down the road, but if you have any questions always feel free to reach out to us at the North Kingstown Planning Department or the Department of Water Supply!

Daniel Codiga (2024). UTide Unified Tidal Analysis and Prediction Functions (https://www.mathworks.com/matlabcentral/fileexchange/46523-utide-unified-tidal-analysis-and-prediction-functions), MATLAB Central File Exchange.

About harmonic constituents - NOAA tides & currents. Tides & Currents. https://tidesandcurrents.noaa.gov/about_harmonic_constituents.html

USGS Water Data for the Nation
National Water Information System: Web Interface · USGS Water Data for the Nation https://waterdata.usgs.gov/nwis