

Time series analysis of water level and temperature in the St Louis River Estuary

David Bolgrien, Brent Bellinger, Ted Angradi, and Mark Pearson

US EPA Office of Research and Development, Duluth, MN

Pressure and temperature loggers were deployed at 9 sites in the St Louis River estuary between 6/23 – 10/31 2011. A reference sensor was placed on the shore to correct pressure data. Sensors were placed at <1 m depth in Allouez Bay, Superior Bay, near Hearing Island, WLSSD Bay, the railroad bridge, Clough Island, Spirit Lake, Oliver Bridge, and St Louis River (Nekuk Island). They recorded data every 15 minutes. Results were compared to historical data of Mortimer and contemporary data from the USGS and NOAA gages at the Duluth canal and outer harbor, respectively. Meteorological data were taken from Sky Harbor airport. There was no seasonal trend in water elevation in the estuary. Consistent with Mortimer, we found tidal oscillations at 23.97 h and 12.39 h and major seiche oscillations at 7.96 h, 4.96 h, 3.82 h, 3.39 h, and 3.04 h. Additional seiche modes, particularly at downstream sites, were weak and highly variable. Oscillations at Oliver Bridge were exceptionally weak, out of phase, and lacked coherency compared to all sites. Water elevations at sites downstream of Clough Island varied in-phase with high coherency for the 8 hour seiche. Elevations in Spirit Lake and the river varied in phase with high coherency. The largest change in hourly elevation was 0.23 m in Allouez Bay and 0.44 m change in the Duluth Canal. In the estuary, in-phase diurnal water temperature oscillations were observed at all sites except Clough Island and Oliver Bridge. Temperatures upstream of the railroad bridge were generally warmer than downstream. Temperatures in the Duluth canal were generally lower than in the estuary. Seasonal temperature maxima (>20°C) were reached in late July/early August. Estuary temperatures decreased (<12°C) and became more uniform by the end of October. Some transient changes in water elevation, temperature, and conductivity (measured at the USGS gage) could be associated with changes in wind direction and current flow through the Duluth Canal. The influence of these events was largely limited to the harbor. These findings do not represent US EPA policy.