Estimating Suspended Solids Concentrations in Estuarine Environments Using Acoustic Instruments

By Eduardo Patino[1] and Michael Byrne[1]

[1]U.S. Geological Survey, Fort Myers, Florida

As part of a cooperative study between the South Florida Water Management District (SFWMD) and the U.S. Geological Survey (USGS), acoustic Doppler instruments were installed at three sites with within the St. Lucie River Estuary system (fig. 1). Information on flow, salinity, water-quality, and channel cross-section characteristics were collected at these sites.

The Doppler instruments were installed to measure an index of the mean water velocity at surface-water monitoring sites. These instruments also record information related to the received strength of the velocity signal, acoustic backscatter (ABS), a parameter affected primarily by the amount of material in suspension. This study involves the development of total suspended solids (TSS) to ABS relations in order to estimate time-series records of TSS concentrations for the monitored sites. In addition to suspended solids, water density also has an effect on the strength of acoustic signals traveling through it. Therefore, salinity and temperature data are also collected at the monitoring sites and used as secondary variables in the estimation model for suspended solids. Sediment samples are collected using a point sampler lowered between the probes that measure water quality and near the Doppler face (fig. 2). The samples are analyzed for TSS and volatile suspended solids (VSS) at the U.S. Geological Survey laboratory in Ocala, Fla.

The results are promising for use of this technique in environments with high organic content in the suspended material. At all of the study sites, measured TSS concentrations ranged from 3 to 23 milligrams per liter with an organic content of between 50 and 70 percent, temperature varied from about 18 to 32 degrees Celsius, and salinities ranged from less than 1 to about 25 parts per thousand. At the North Fork site, TSS concentrations ranged from 3 to 18 milligrams per liter, and salinities ranged from greater than 1 to 15 parts per thousand. The resultant equation currently used for estimating TSS concentrations represents a relation in the “local” space (point samples collected near the instruments). The relation for the North Fork monitoring station is as follows:

$$TSS = 10^{\{ABS[0.06232 + 0.00118*\log(sal) - 0.02212*\log(temp)] - 1.32321\}}$$

R^2 (correlation coefficient) = 0.86

The relation of estimated to measured TSS concentrations is shown in figure 3. Measured concentrations used in the regression analysis for the development of the estimating equation and verification measurements are presented.

At the present time, this project includes an expansion of the “local” TSS to ABS relation to represent a relation to the mean cross-sectional concentrations at monitoring sites. Preliminary data suggest that results similar to the local relation will be possible in the future. At that time, TSS fluxes will be calculated.

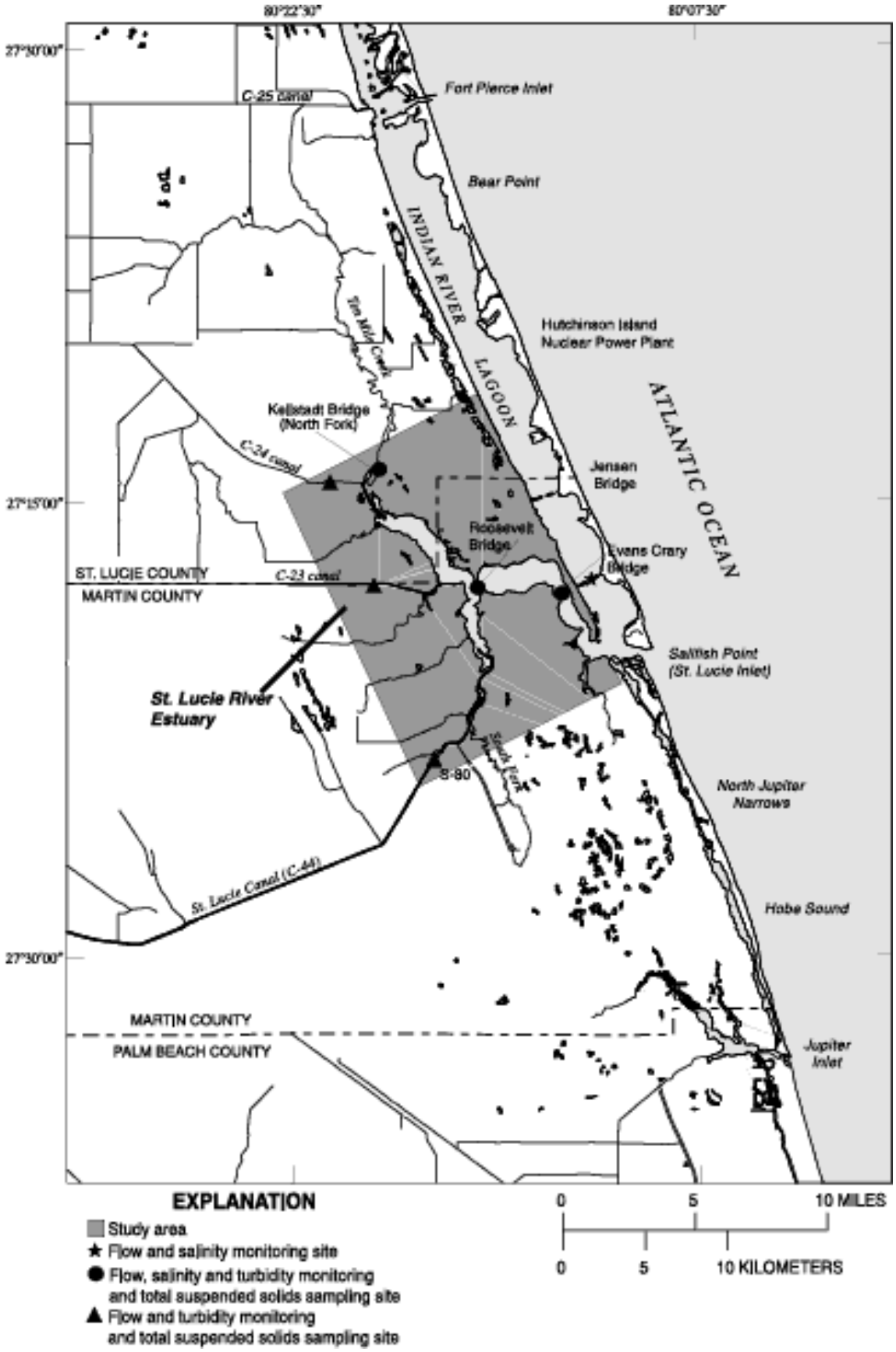

Figure 1. Location of monitoring sites within the St. Lucie River Estuary, Florida

A new fig 2 will replace this one!

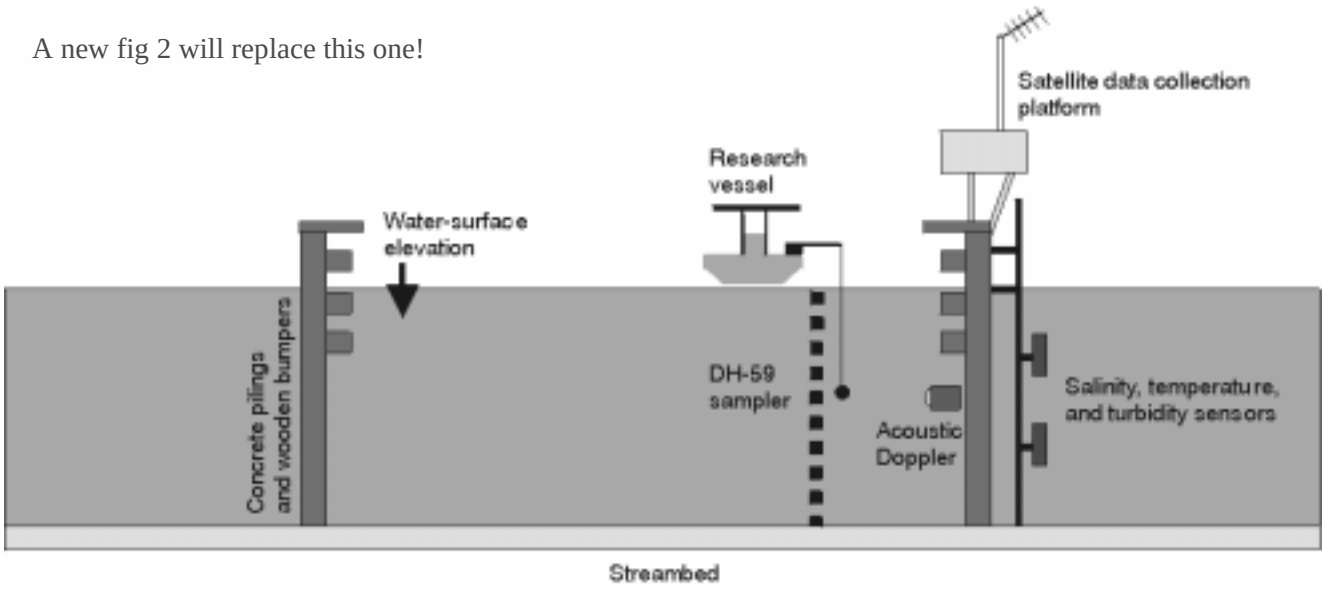

Figure 2. Instrument setup for monitoring sites at the St. Lucie River Estuary.

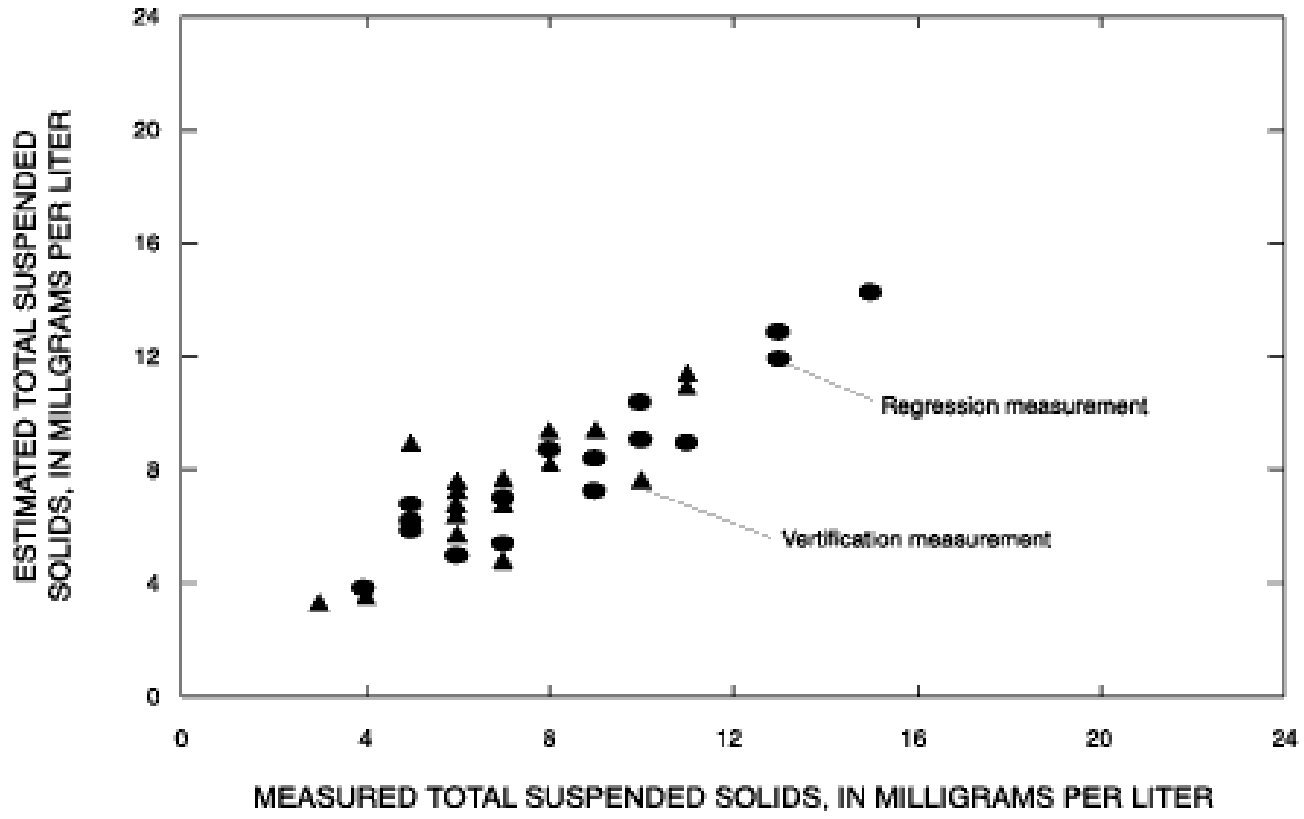

Figure 3. Measured to estimated total suspended solids concentrations comparison at the North Fork site.