

# SOUTH TOE RIVER LANDSLIDE STUDY

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# BACKGROUND

- One of over 2000 landslides caused by Hurricane Helene
- Has seen minimal improvement in the two years since





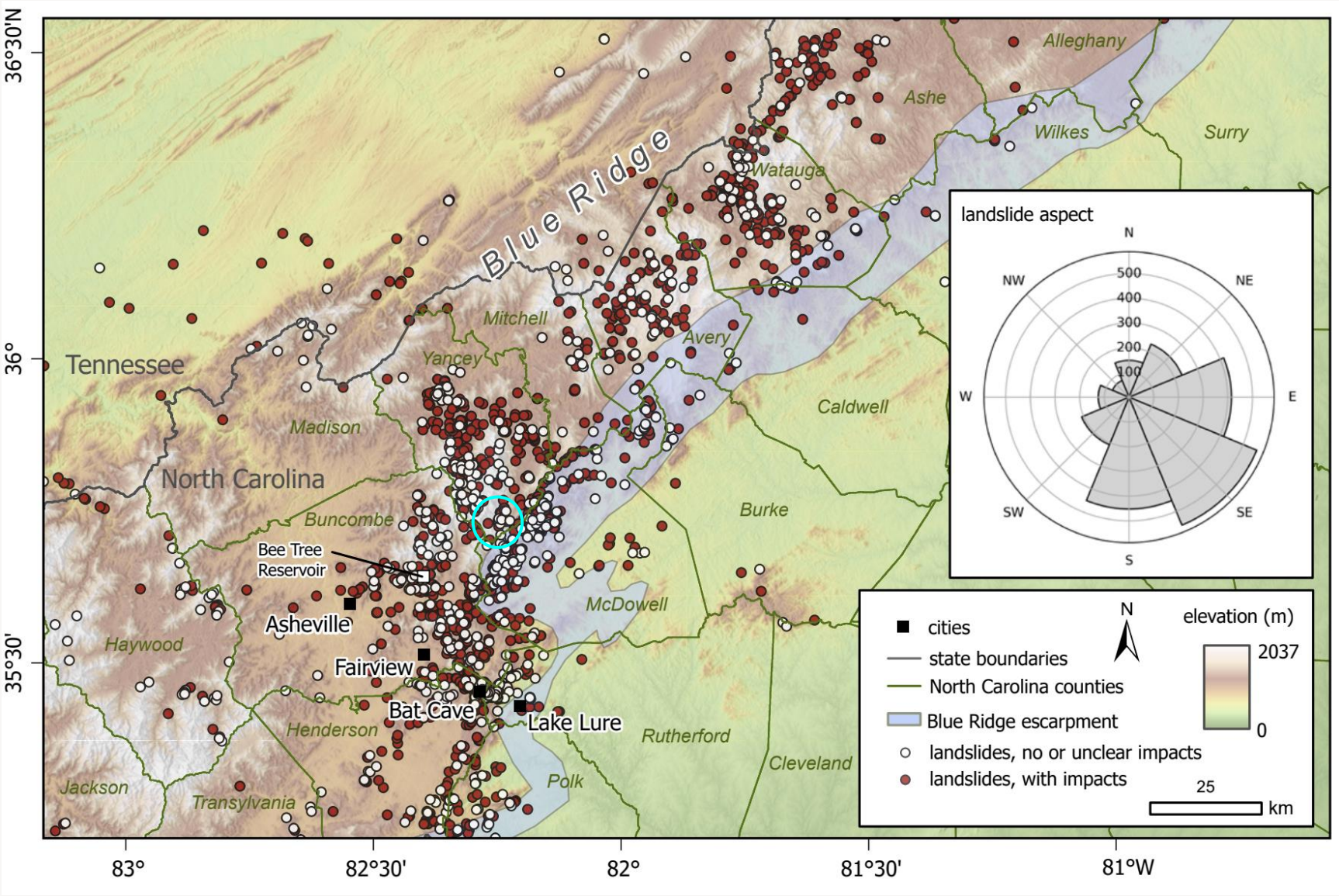




Map of landslides in the surrounding areas

South Toe landslide in blue circle

Map provided in article published by the Geological Society Association in early 2026



# 2024 IMAGERY







# 2025 IMAGERY

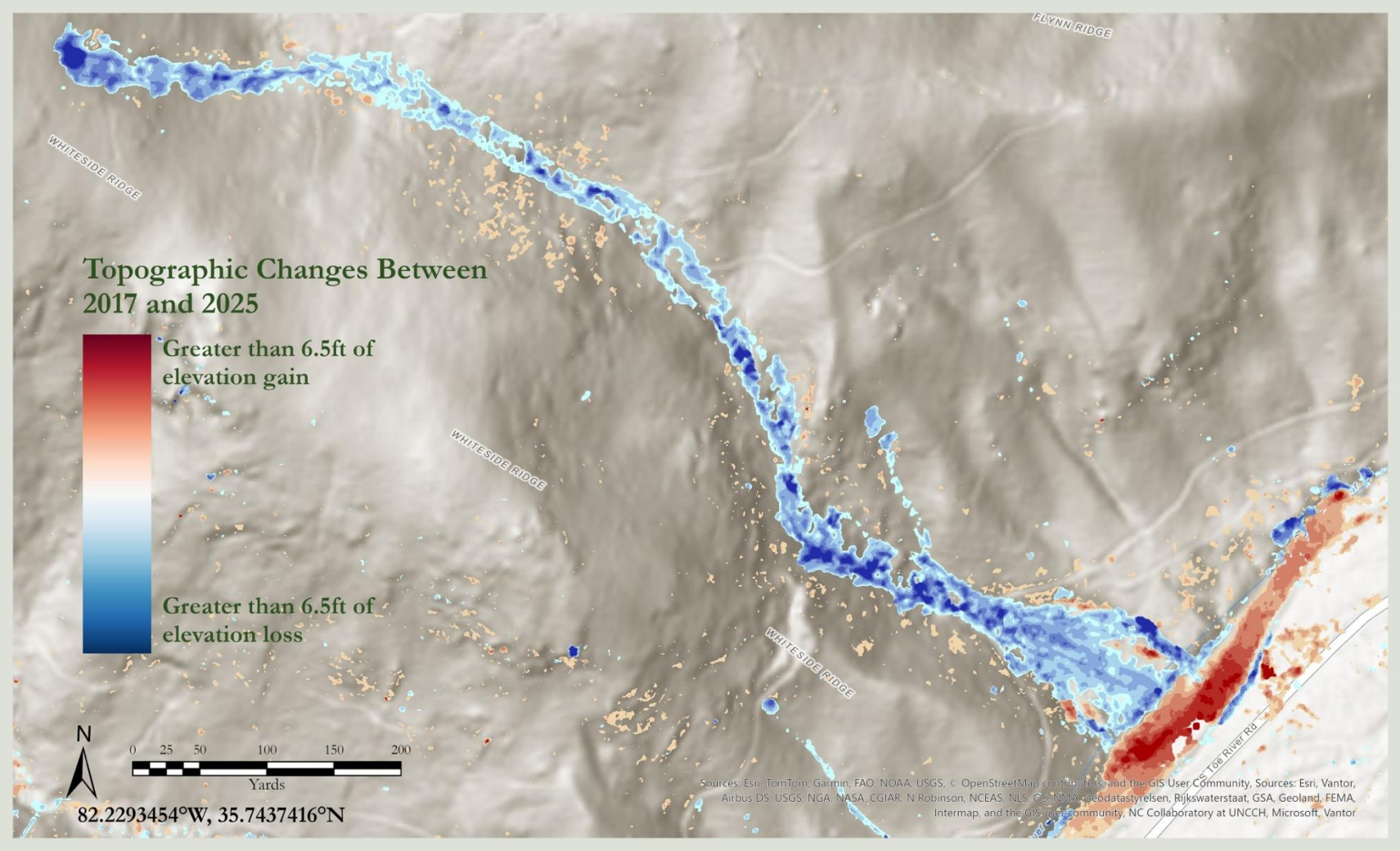





# STUDY OBJECTIVES

1. Develop site-specific empirical relationships between turbidity and suspended sediment concentration.
2. Compute continuous time-series estimates of suspended sediment concentration at study sites.
3. Compare upstream and downstream sediment loads to estimate impact of landslide.
4. Provide data to inform restoration efforts and watershed management strategies in western North Carolina.

# GIS ANALYSIS



# SITE SELECTION





Sonde installation at upstream site



Auto-sampler installation at upstream site



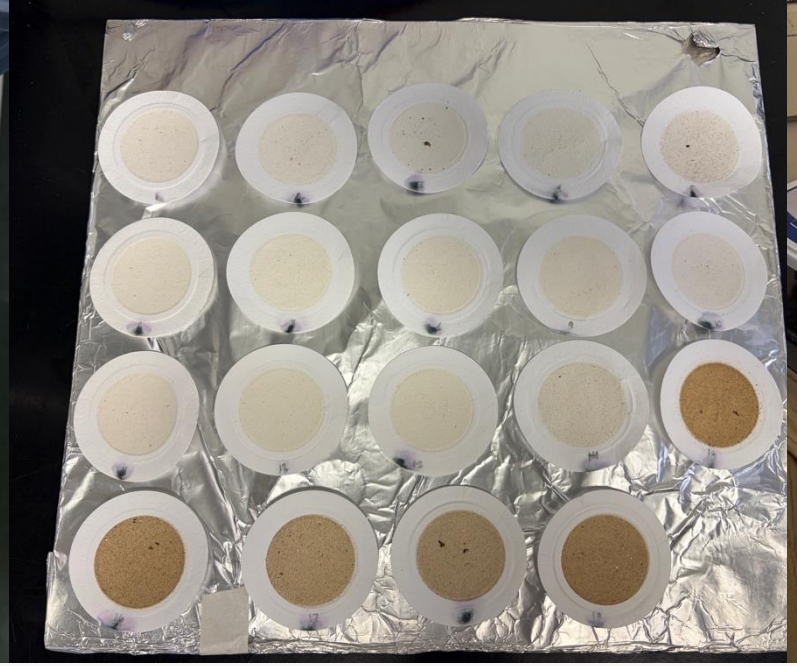
Sonde installation at downstream site

# SENSOR AND SAMPLER INSTALLATION

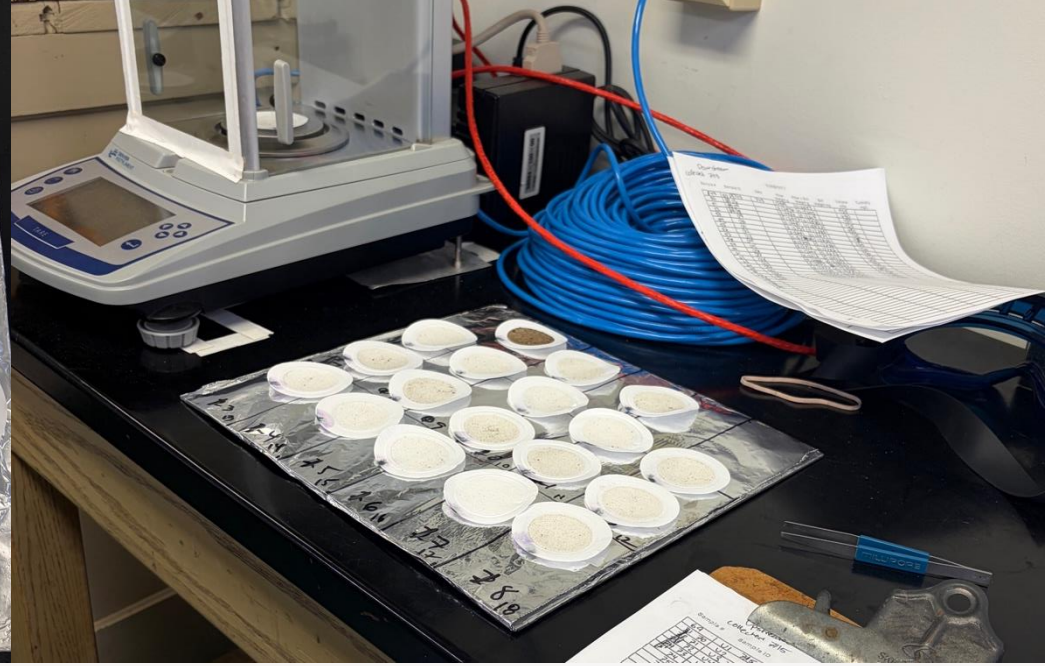
- One sensor and one sampler each were installed upstream and downstream of the debris flow
- We chose sites that appeared to be well-mixed and representative of the river as a whole
- Samplers were taken from the same place the turbidity sensor was placed
- Turbidity measurements are taken every 15 minutes



Downstream samples from 7/11-7/13



Downstream samples from 7/20

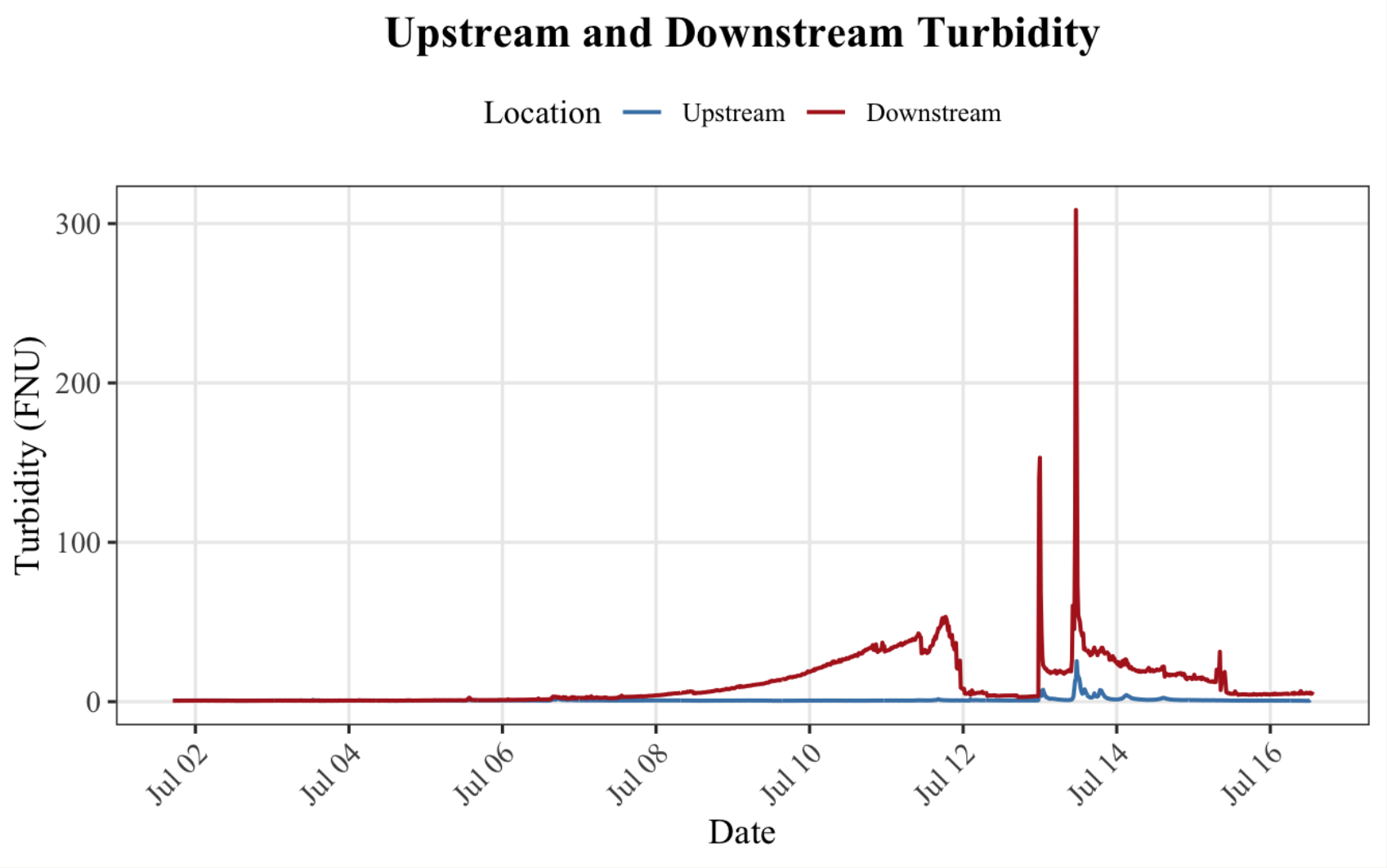


Upstream samples from 7/13

# SAMPLE ANALYSIS

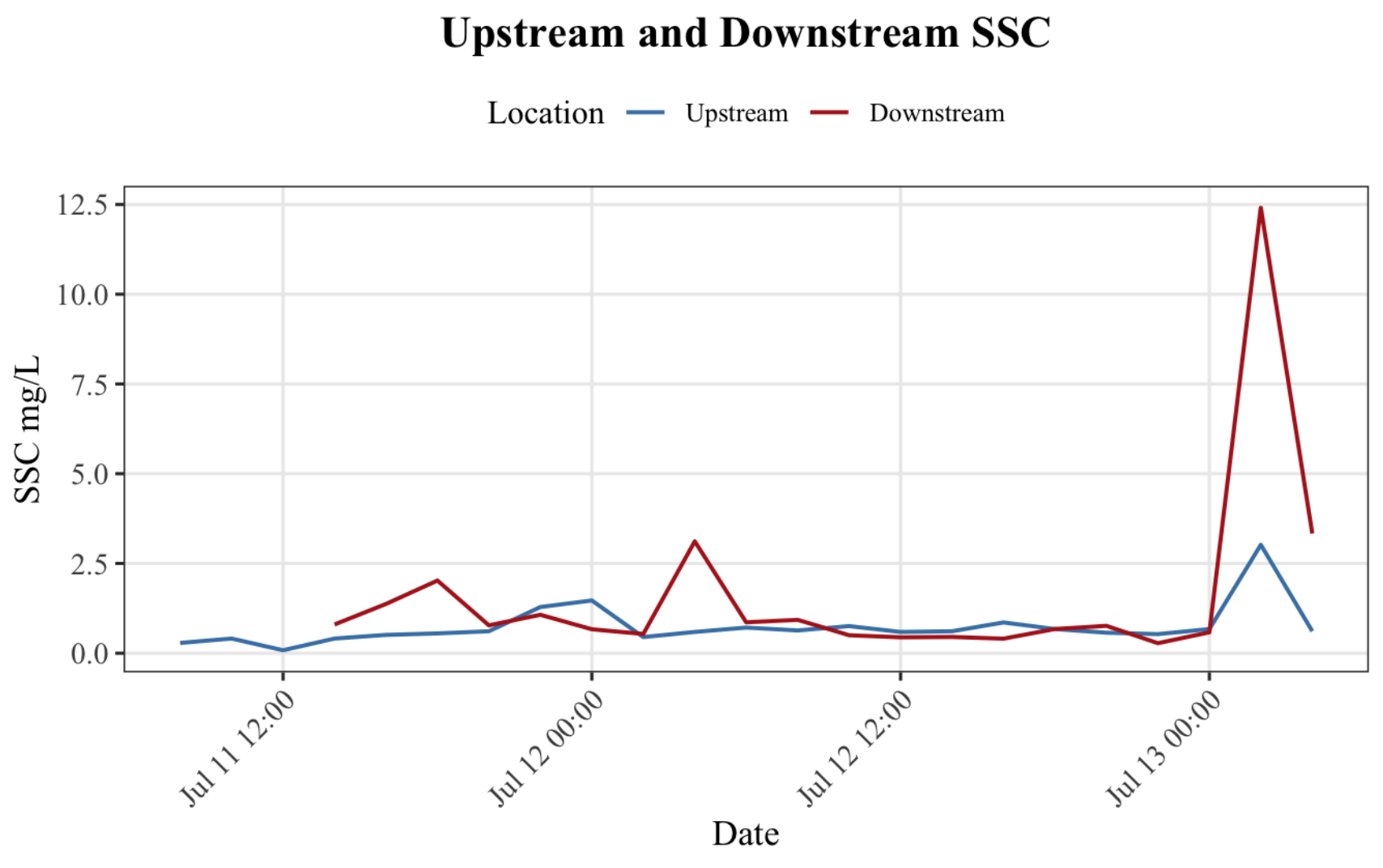
- Roughly 500 ml of sample was collected in 30min-2hr intervals
- Samples were gravimetrically analyzed for suspended sediment concentration
- Used procedure provided at Coweeta Hydrologic Laboratory

# TURBIDITY RESULTS



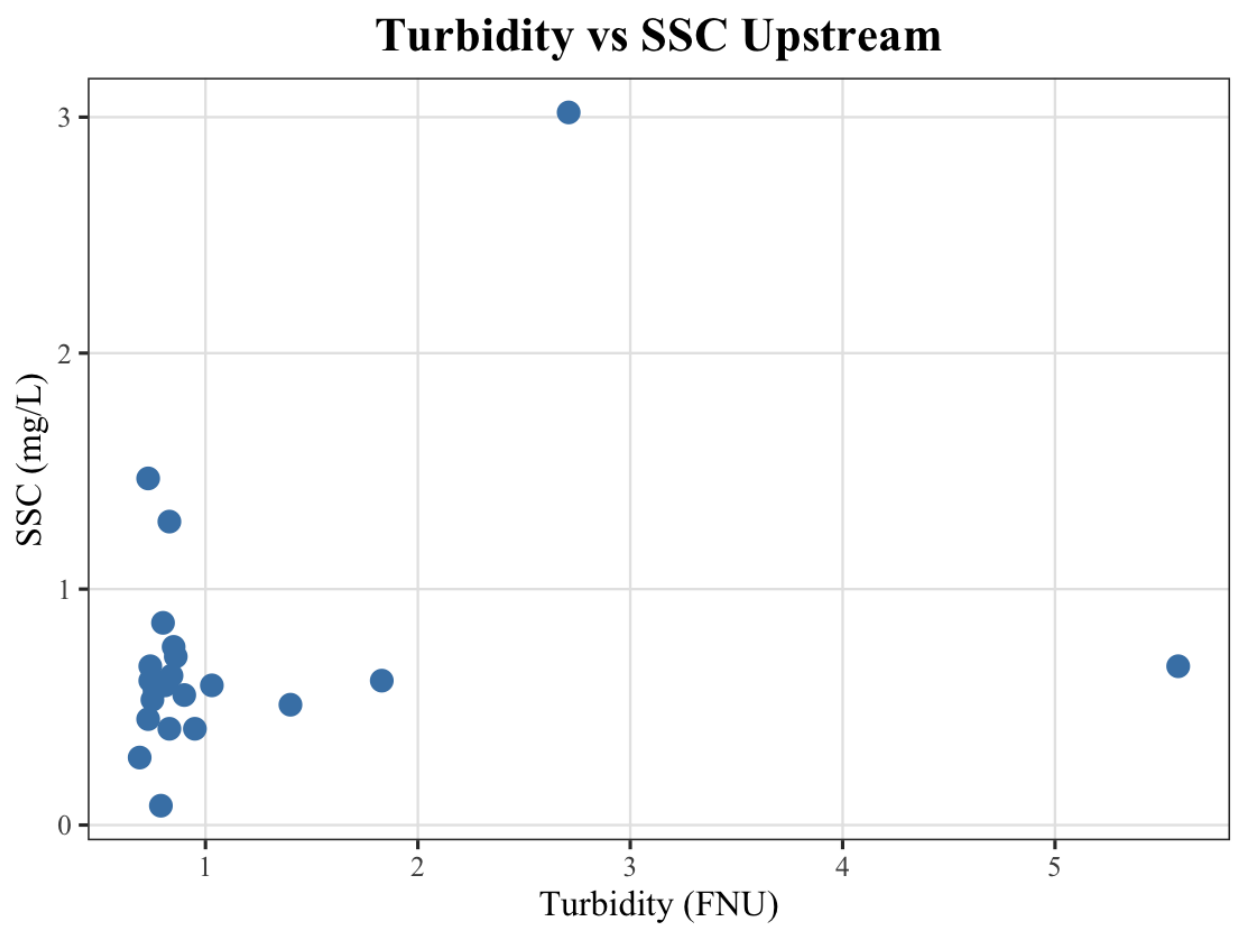

| | Upstream | Downstream |
|---|---|---|
| Mean Turbidity | 1.04 | 10.95 |
| Max Turbidity | 25.40 | 308.54 |
| Min Turbidity | 0.53 | 0.53 |

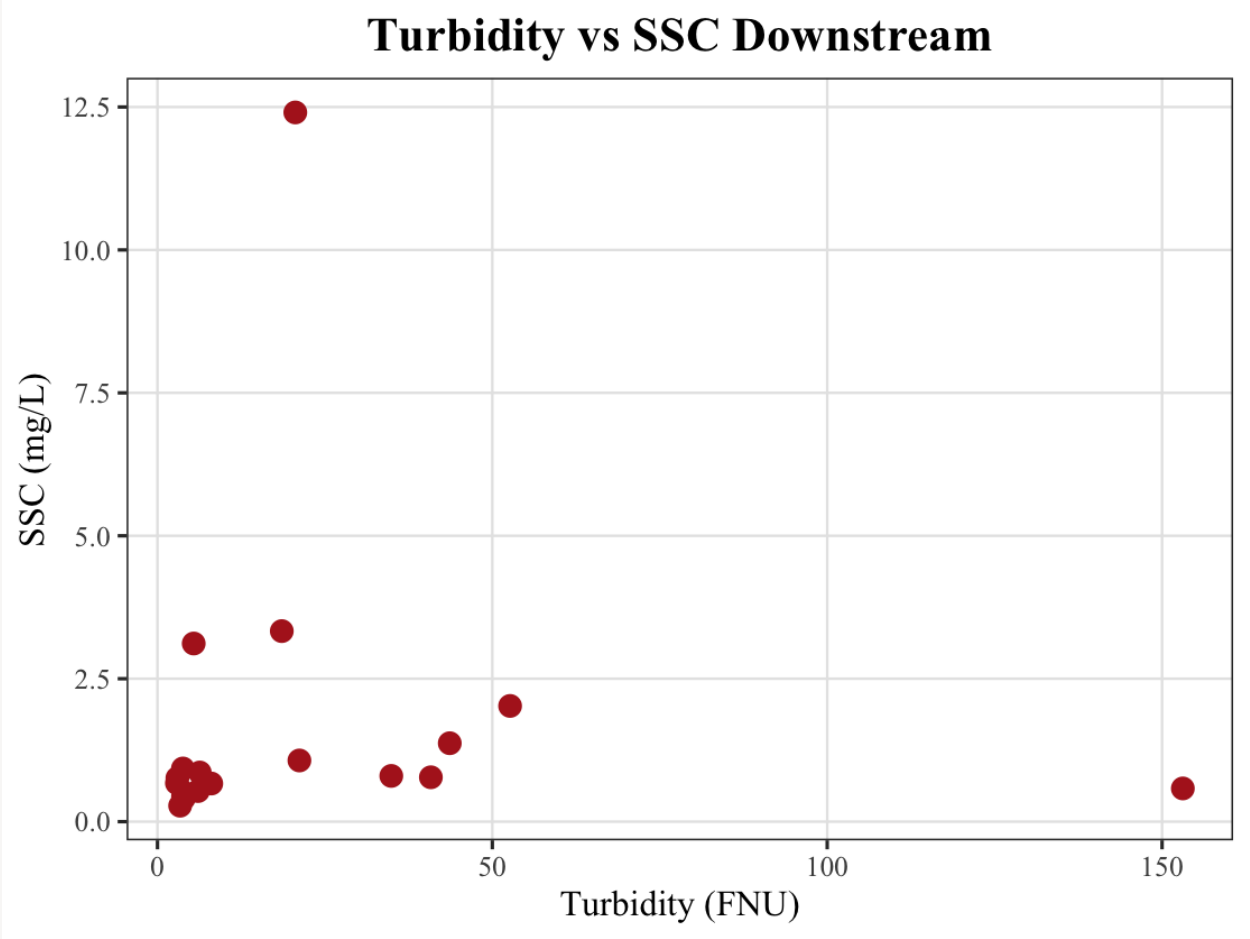
# SUSPENDED SEDIMENT CONCENTRATION RESULTS



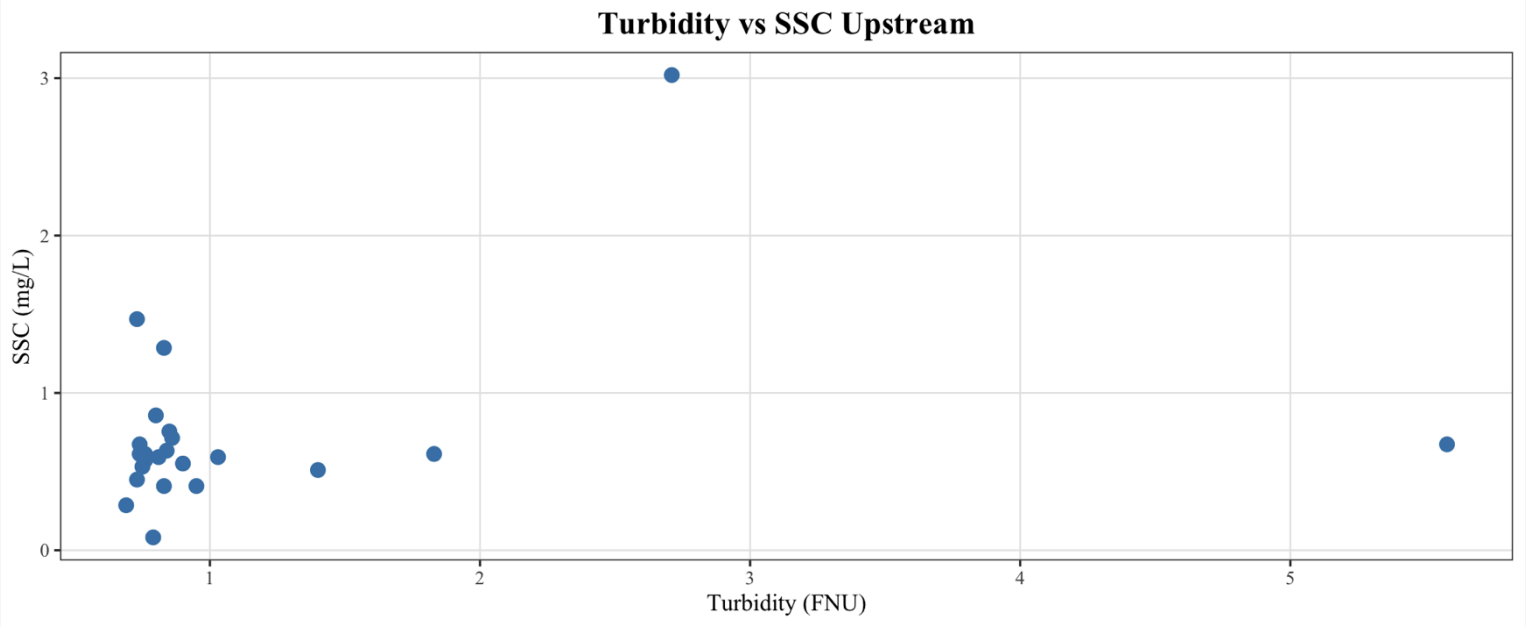

| | Upstream | Downstream |
|---|---|---|
| Mean SSC | 0.735 | 1.599 |
| Max SSC | 3.020 | 12.405 |
| Min SSC | 0.082 | 0.279 |

# TURBIDITY VS SSC

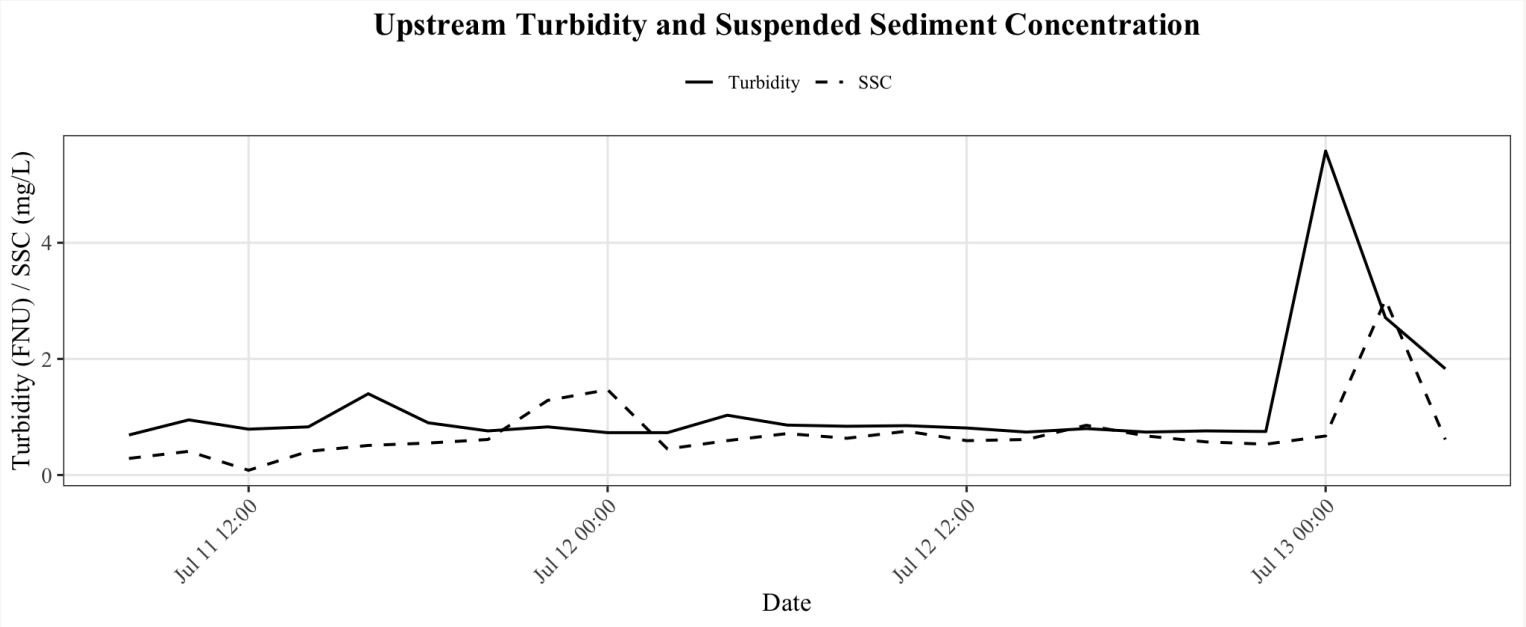


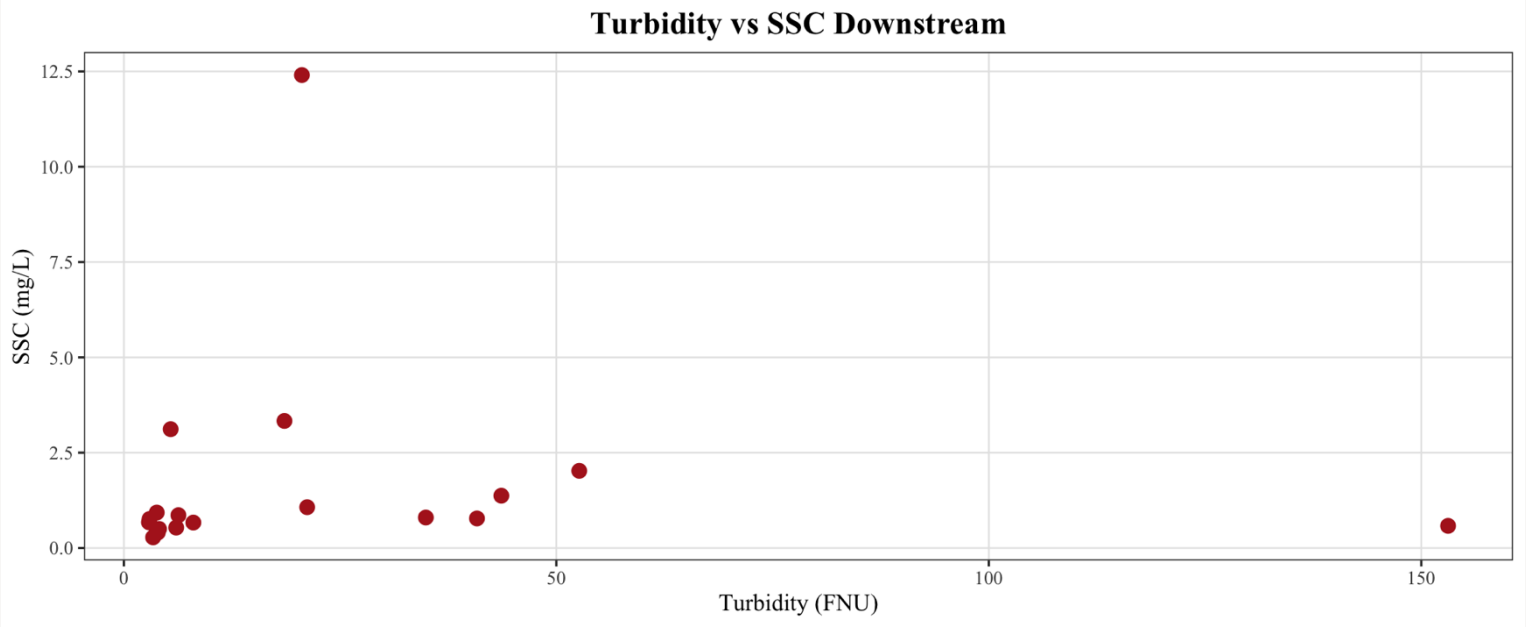
# TURBIDITY VS SSC UPSTREAM



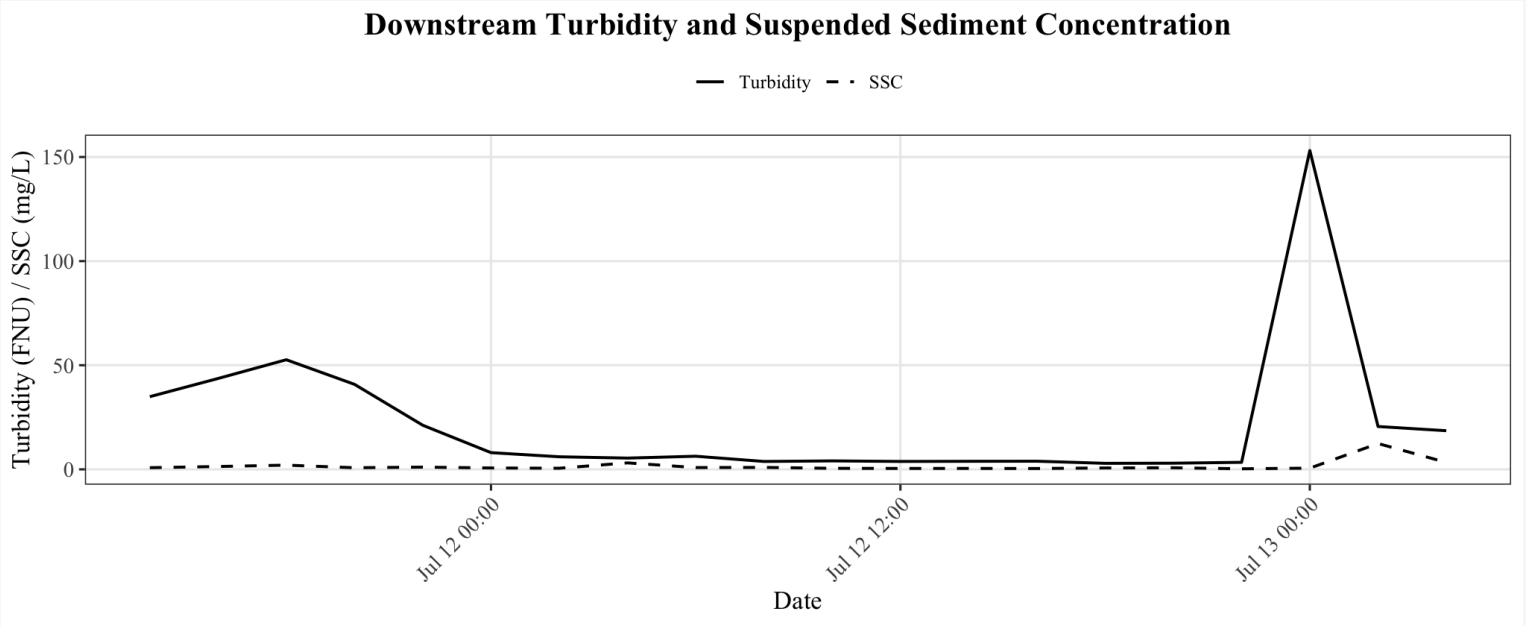

# TURBIDITY AND SSC TIME-SERIES UPSTREAM



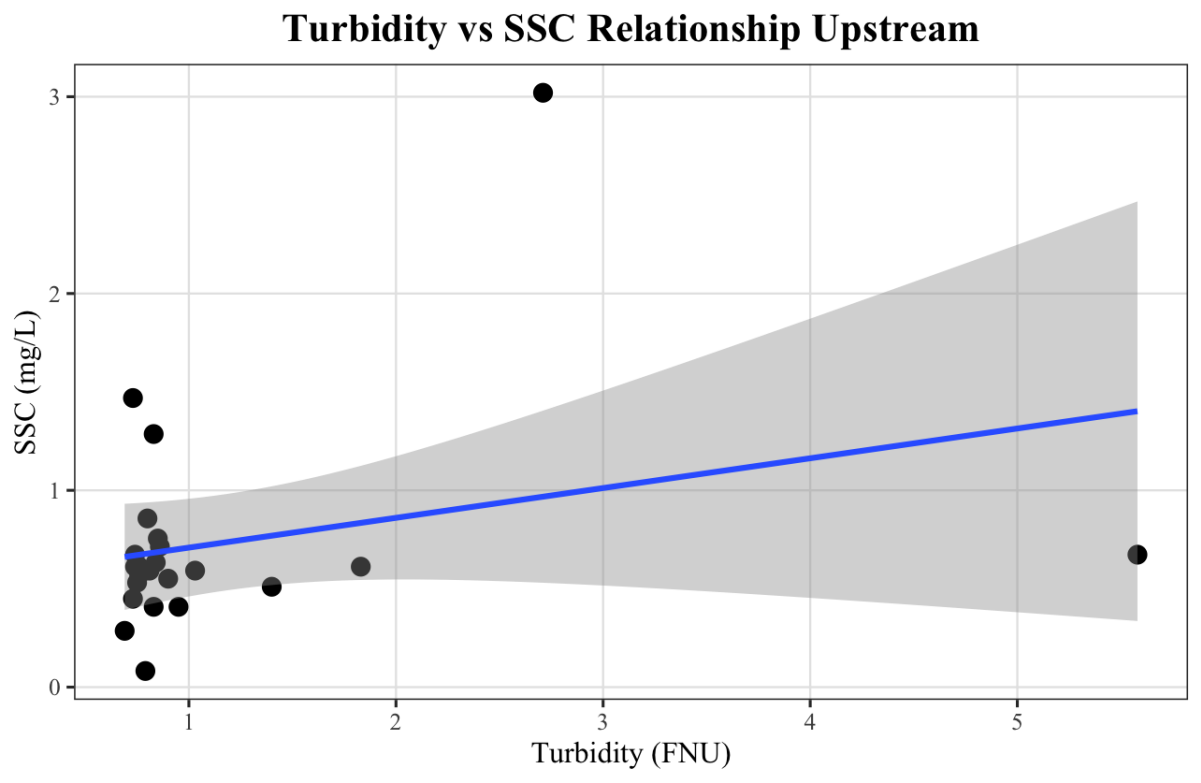
# TURBIDITY VS SSC DOWNSTREAM




# TURBIDITY AND SSC TIME-SERIES DOWNSTREAM



# UPSTREAM STATISTICAL ANALYSIS



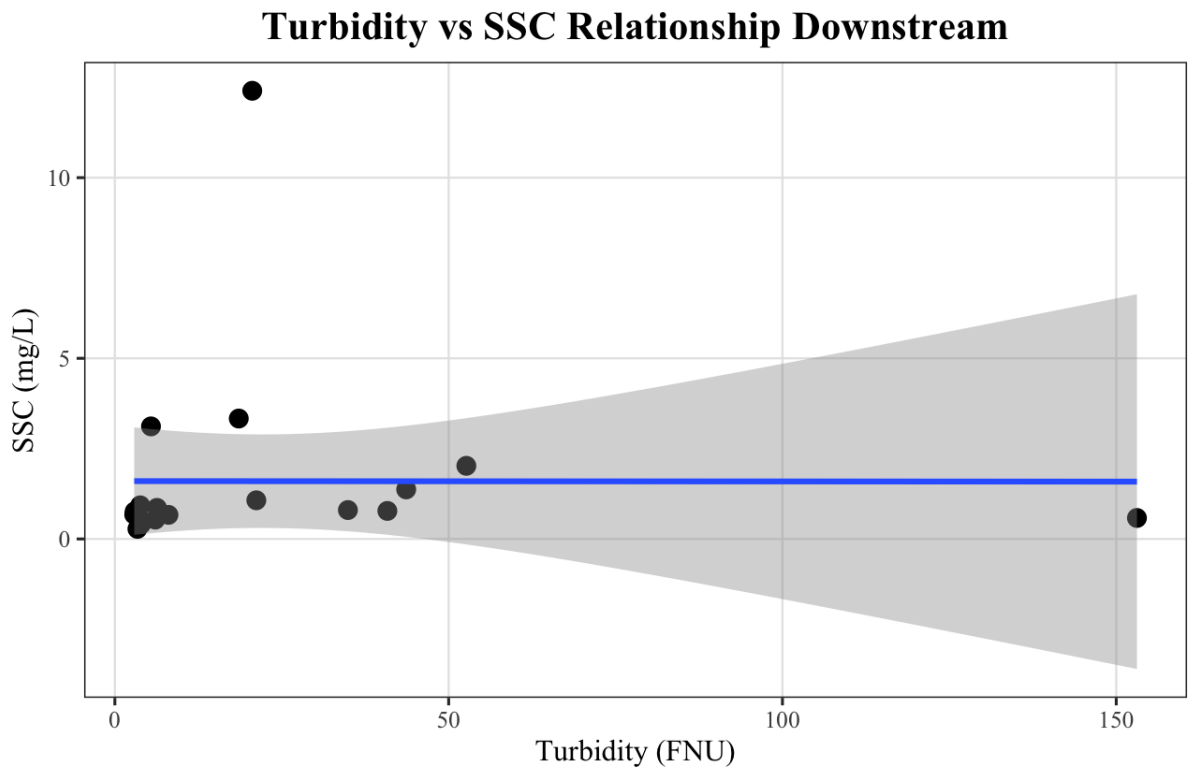

```
Call:
lm(formula = SSC..mg.L. ~ Turbidity..FNU., data = upstream_SSC)

Residuals:
     Min       1Q   Median       3Q      Max
-0.72892 -0.24094 -0.10157  0.01488  2.05236

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)       0.5576     0.1771   3.148  0.00485 **
Turbidity..FNU.   0.1513     0.1131   1.338  0.19530
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5644 on 21 degrees of freedom
Multiple R-squared:  0.07852,   Adjusted R-squared:  0.03464
F-statistic: 1.789 on 1 and 21 DF,  p-value: 0.1953
```

# DOWNSTREAM STATISTICAL ANALYSIS




```
Call:
lm(formula = SSC..mg.L. ~ Turbidity..FNU., data = downstream_SSC_turb)

Residuals:
    Min      1Q  Median      3Q     Max
-1.3219 -1.0744 -0.8302 -0.4532 10.8057

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      1.601e+00  7.349e-01   2.179   0.0429 *
Turbidity..FNU. -9.381e-05  1.823e-02  -0.005   0.9960
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.754 on 18 degrees of freedom
Multiple R-squared:  1.471e-06, Adjusted R-squared:  -0.05555
F-statistic: 2.647e-05 on 1 and 18 DF,  p-value: 0.996
```

# NOTES ON INITIAL STATISTICAL ANALYSIS

- Tried a log transform, did not dramatically improve the correlation
- Some large outliers, will evaluate their validity once we have more data points
- We do not have turbidity data for the downstream 7/20 samples yet, hopefully once we do they will offer additional insight
- The samples from upstream 7/13 likely cannot be used due to uncertainty on the time they were collected

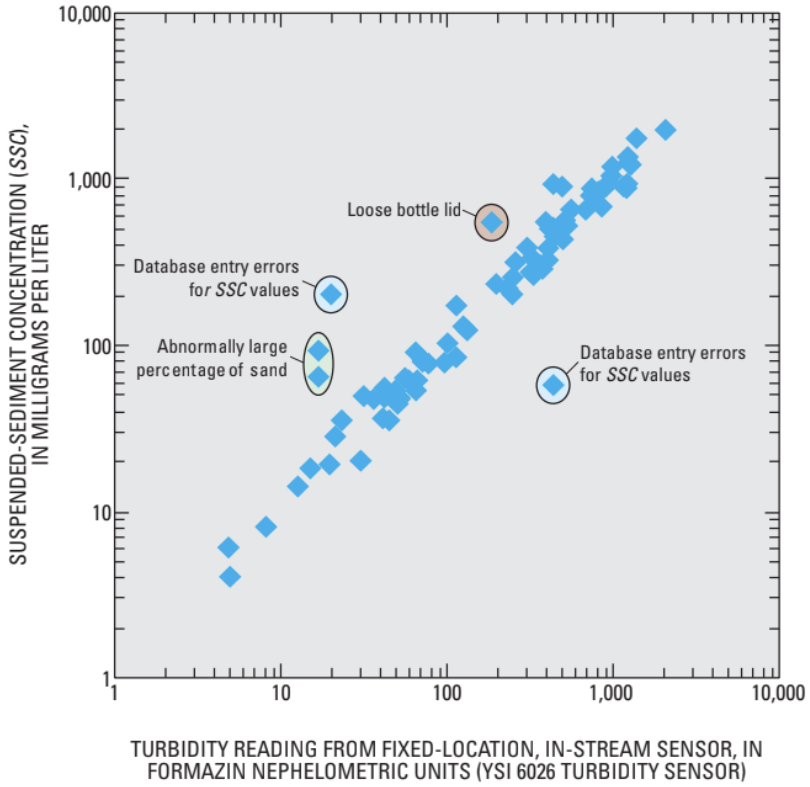



**Figure 6.** Comparison of turbidity to suspended-sediment concentration in water from U.S. Geological Survey streamgage on Little Arkansas near Sedgwick, Kansas, August 2000–June 2005.

# NEXT STEPS

1. Look further into reasons for weak correlation with initial data
2. Investigate any other trends in the data not immediately obvious
3. Analyze samples collected during the week of 8/3

We have made good initial progress on the first two study objectives. In the next few months, with some additional data, hopefully we will be able to establish a better correlation.


Thank you!

# SOURCES


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