Restoration Strategies Science Plan

Evaluation of Sampling Methods for Total Phosphorus

Data Collection Efficacy and
Qualitative Observations of Sampling

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Quarterly Communications Meeting on the Long-Term Plan for Achieving Water Quality Goals for the Everglades Protection Area Tributary

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Remote Environmental Sampling Test (REST)

- REST Project is looking inside the sampling process
  - Observing field conditions even when staff are not present
  - Reviewing sampling processes and assumptions
- REST hopes to provide information on sampling performance to improve quantification of system performance, user understanding, and data interpretation

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Sampling Efficacy

- Does the STA monitoring program produce the number of useful samples it was designed to?
  - The District generally defines data completeness goals at 95% (2 event failures acceptable/yr)
- Only looking at
  - Flow Proportional Composites (ACF),
  - Time proportional discrete samples (ADT)
  - Grabs
- RPAs and DataSondes will be discussed in the full report

Understanding How Flow proportional Autosamplers Function

- In order to even begin the conversation, a basic understanding of monitoring processes is needed, particularly flow proportional sampling
- Grab samples are simple
  - Single point in space and time
- ADT (time proportional autosamplers) samples are a little more complicated
  - A single point in space with multiple sampling events with a defined temporal cycle
- ACF (flow proportional autosamplers) samples are complex
  - A single point in space with multiple sample events initiated by the amount of volume passed through a feature

Understanding Autosampler Functions Flow measurements and Triggers

- The vast majority of District structures have associated flow measurements
  - Near instantaneous
  - Preliminary data is reviewed
  - Quality assured flow data eventually stored in open database
- Structures with ACFs have a secondary system **Sample Flow Totalizer**,
  - Uses a duplicated flow measurement equation
  - Sums positive flows and sends a signal at each iteration of a defined **trigger volume, this may take weeks or even months**
  - WQ Monitoring Staff have no access to the totalizer, and cannot halt the program or reset the sum to zero
- Trigger Volumes are calculated based on structure capacity and designed to make sure that the majority of flow is captured without overflowing the autosampler
- If Totalizer or communications fail the ACF can be switched to an ACT producing some useful data, but such data is not considered when calculating completeness for the method

Understanding Autosampler Functions NOBs

- No Bottle Collected samples (NOBs) can be created in four ways
  - No Flow
  - Flow too low to reach the trigger volume, grab data acceptable
  - Sample volume too low to dilute acid
    - Bottles are pre-acidified and often a single trigger event is insufficient to dilute the acid to a pH level that is suitable for the laboratory, grab data acceptable
  - Sampling Failure
    - Equipment malfunction, grab data used as a substitute but situation not considered acceptable

Station G310

Pump Station that functions as the primary discharge from STA1W into WCA1

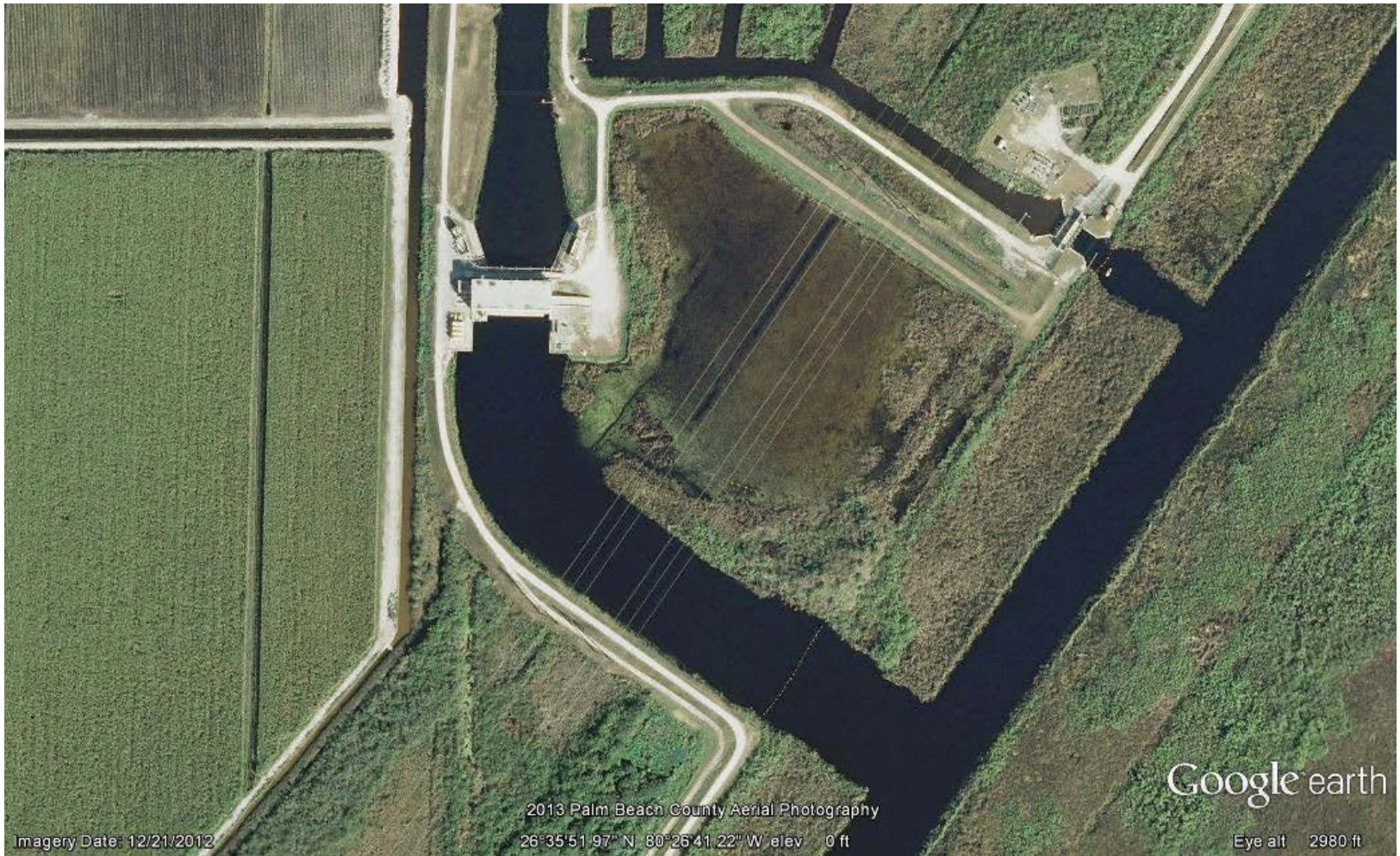


Figure 1. Images of the intakes at G310 showing still waters, and particles suspended during flow events

Figure 2. Southern Naiad wrapped around the sampling tubes at G310

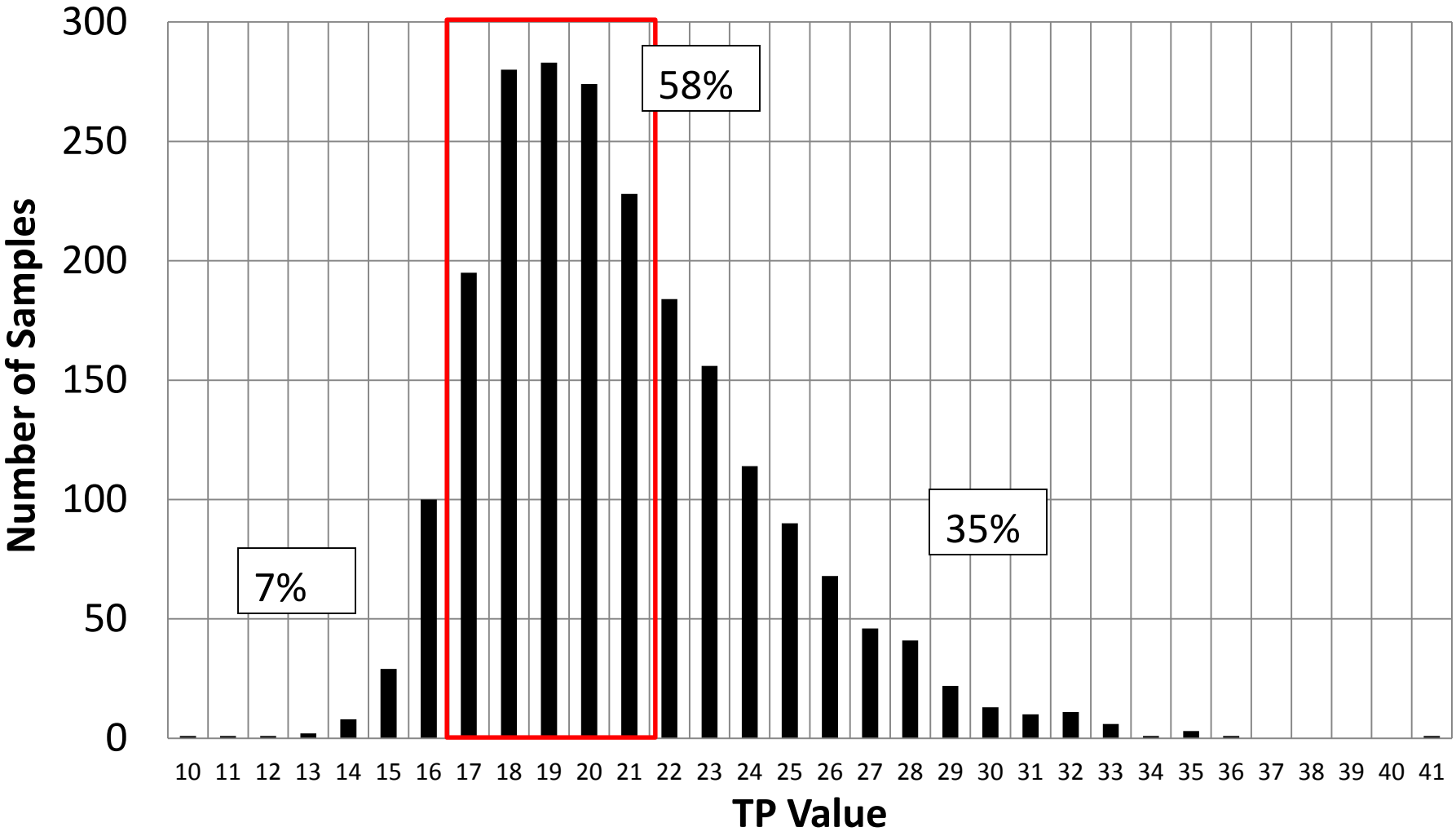
Figure 3. Floating mats of uprooted cattail at G310

Observations on Sampling Efficacy

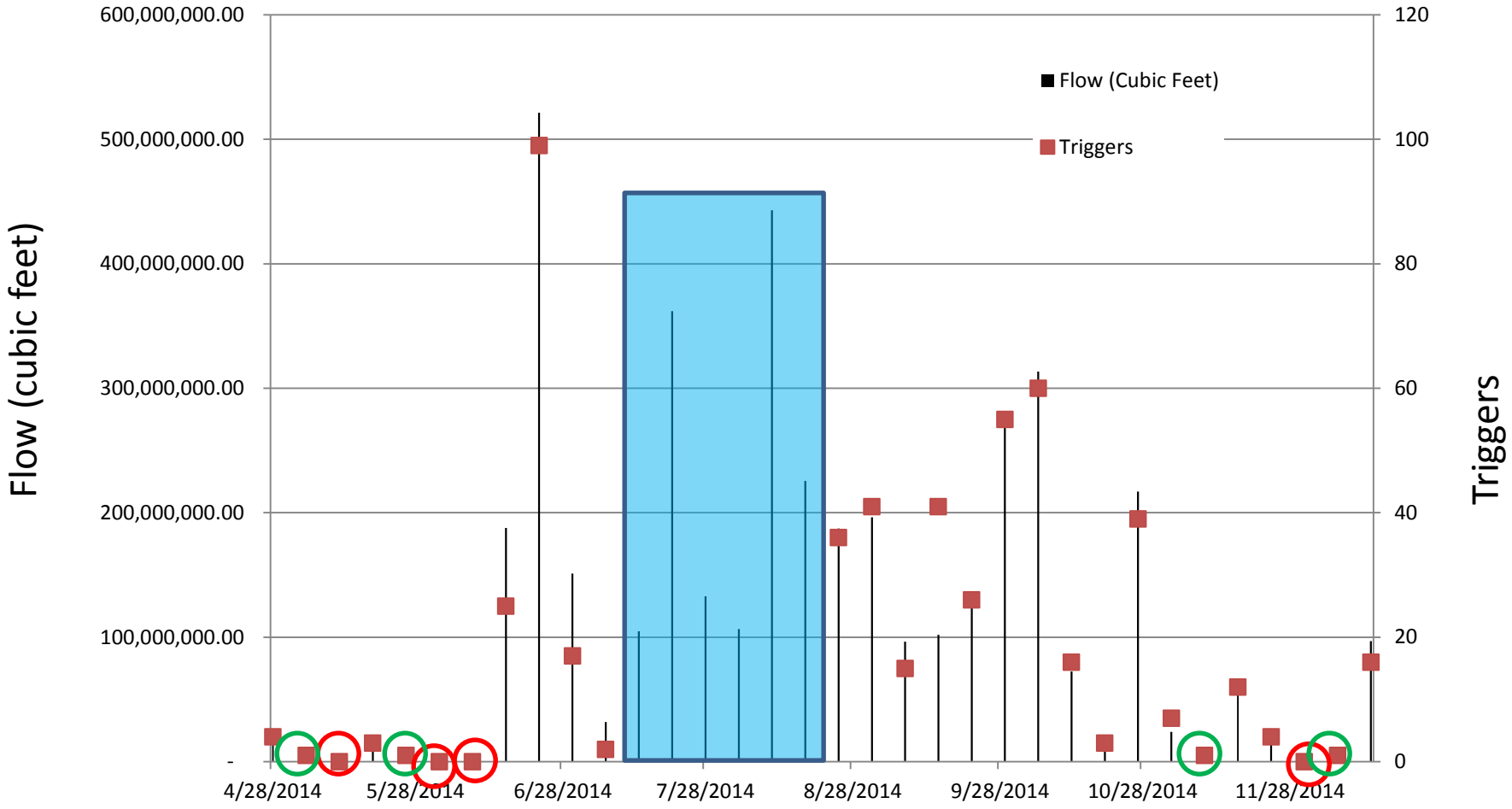
G310 Data Expectations and Results sampling from 4/21/14 -12/15/14

Type	Expected	Actual	Percentage
Grab	35	35	100%
ADT	238	235	99%
ACF and NOB	34	28	82%
ACF-ACT	0 (34)	6	18%

Distribution of RPA TP data at G310 sampled every 2 hours over 34 weeks



Weekly Flows and Number of ACF Triggers at G310 (5.2 Million Cubic Feet)



4 No Trigger events

4 One Trigger events

6 ACT events

ACF Converted to ACT

- SCADA communication failure for six weeks in July and August 2014
- Monitored using an alternative method
  - considered a sampling failure in terms of completeness
- Disproportionate impact
  - 6 weeks represents 18% of the sampling period
  - Represents 34% of the flow during that period

Observations on Sampling Efficacy

Time v. Flow Based Efficacy for ACF at G310

- Based on Time of 34 weeks and 4,024 Million Cubic Feet (MCF)
  - ACF produced analyzable samples for
    - 20 weeks (59%)
    - 2,628 MCF (65.5%)
  - ACF produced NOB for
    - 8 weeks (24%)
    - 21 MCF (0.5%)
  - ACF converted to ACT for
    - 6 weeks (17%)
    - 1,375 MCF (34%)
- Estimates of completeness
  - Time 83%
  - Flow 66%
- REDO FOR ENTIRE YEAR!!!

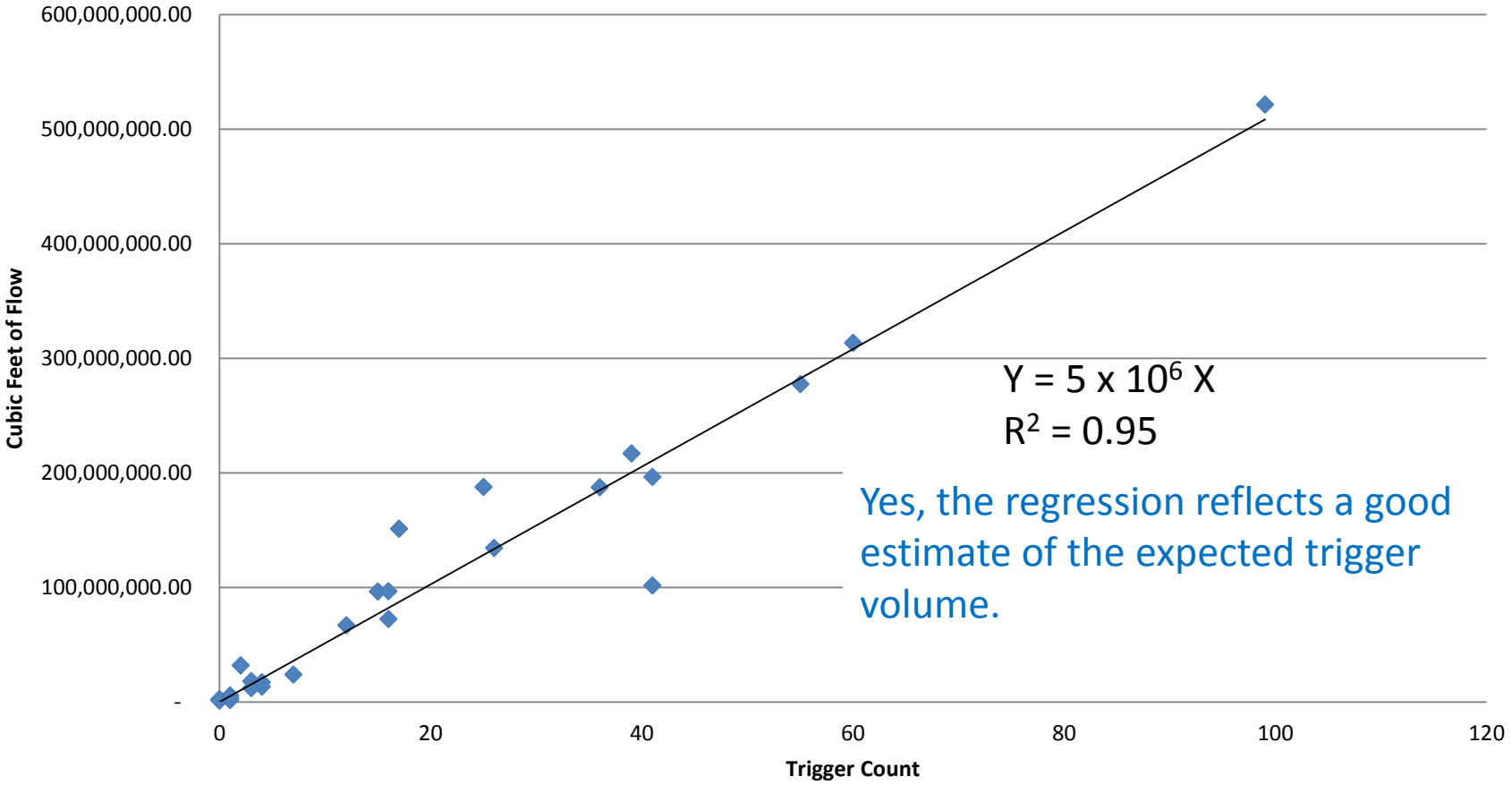
Observations on Sampling Efficacy

Time v. Flow Based Efficacy for ACF at G310

- Based on Time of 52 weeks and 5,446 MCF
  - ACF produced analyzable samples for
    - 29 weeks (56%)
    - 3,469 MCF (64%)
  - ACF produced NOB for
    - 16 weeks (31%)
    - 35 MCF (0.6%)
  - ACF converted to ACT for
    - 6 weeks (11%)
    - 1,375 MCF (25%)
  - Power failure (Recorded as a NOB)
    - 1 week (2%)
    - 567 MCF (10%)
- Estimates of completeness
  - Time 87%
  - Flow 65%

Validating the Trigger Volume

Was G310 ACF functioning properly?
Expected trigger volume= 5.2 MCF



Yes, the regression reflects a good estimate of the expected trigger volume.

Figure 12A. A progression showing the arrival of a floating mat of cattails at G310.

Figure 12B. A progression showing the persistence of a floating mat of cattails at G310.

Figure 12C. A progression showing the departure of a floating mat of cattails at G310 just minutes before staff arrive.

G390B

Gate that functions as the primary source of water to the PSTA in STA3/4

Observations on Sampling Efficacy

G390B Data Expectations and Results from 2/3/14 to 9/29/14

Type	Expected	Actual	Percentage
Grab	35	35	100%
ADT	238	238	100%
ACF and NOB	34	34	100%

Distribution of RPA TP data at G390B sampled every 2 hours over 34 weeks

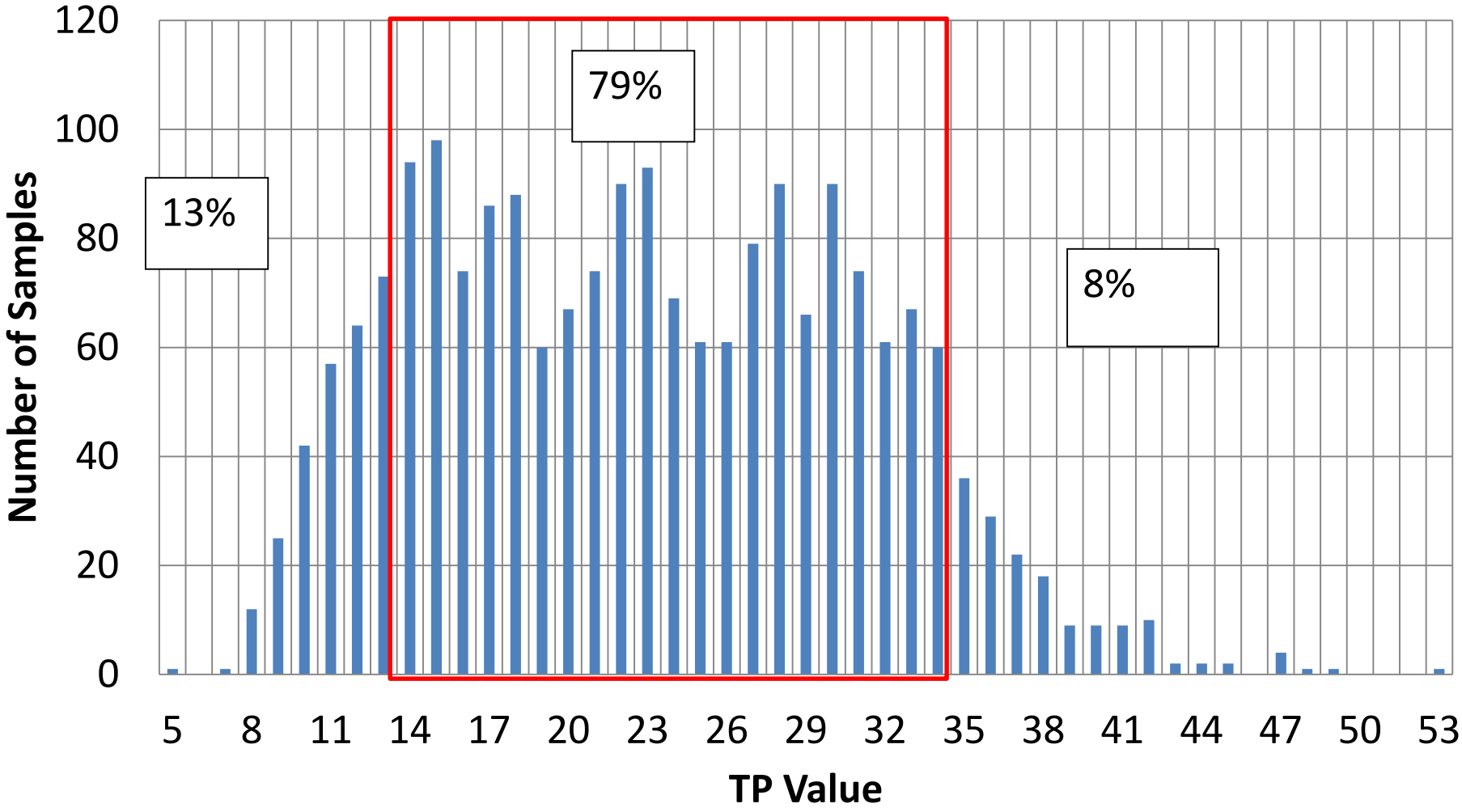
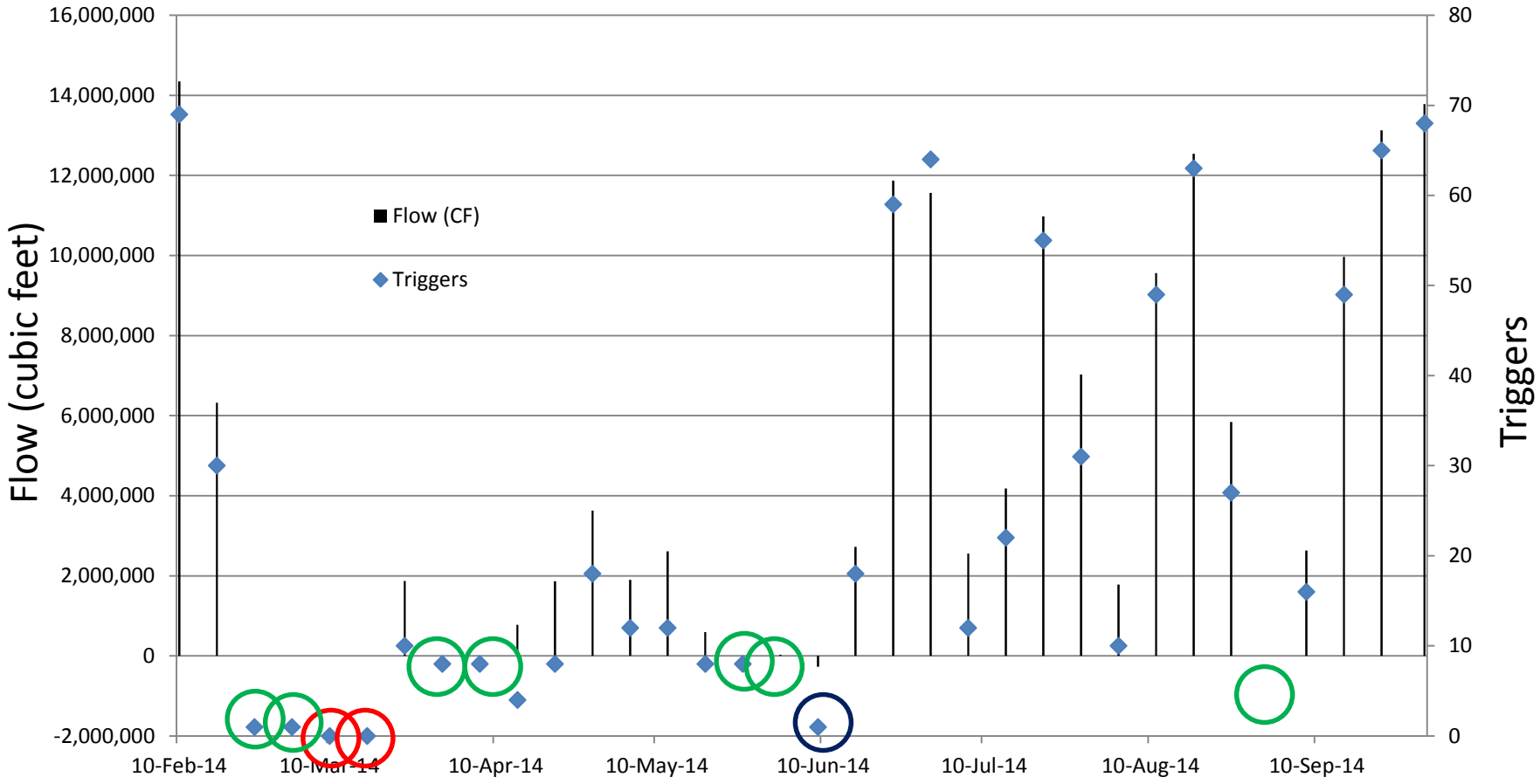


Figure 6A. A school of fish at G390B

Figure 6B. A bass, sunfish and anhinga at G390B

Weekly Flows and Number of Triggers at G390B (312K Cubic Feet)



2 No Trigger events

7 Triggers with No Flow events
(2 Missing Data)

1 Trigger on Negative Flow

Why are there triggers when flow is 0 or negative?

- Three Causes
  - The structure experienced real positive and negative flows and the positive flows were enough to trigger the sampler, but the sums of flows for the week were either zero or negative
  - The structure experienced phantom flow
    - Noise in the stage data that generates flow data in the primary system and the totalizer
    - Primary flow data changed to 0 following quality assurance guidelines
  - Both of these in combination

Negative, Phantom and Low Flows

- Appear to have the potential to
  - Bias the number of sampling events
  - Bias the water quality data
  - Move the resting point of the totalizer away from zero before actual flow events occur
- Might be a factor in creating the multiple peak distribution in the TP data from G390B

Figure 7. An anhinga and a turtle, and the resulting detritus from the turtle's activity

Figure 9. Bird feces rapidly dispersing in the water column.

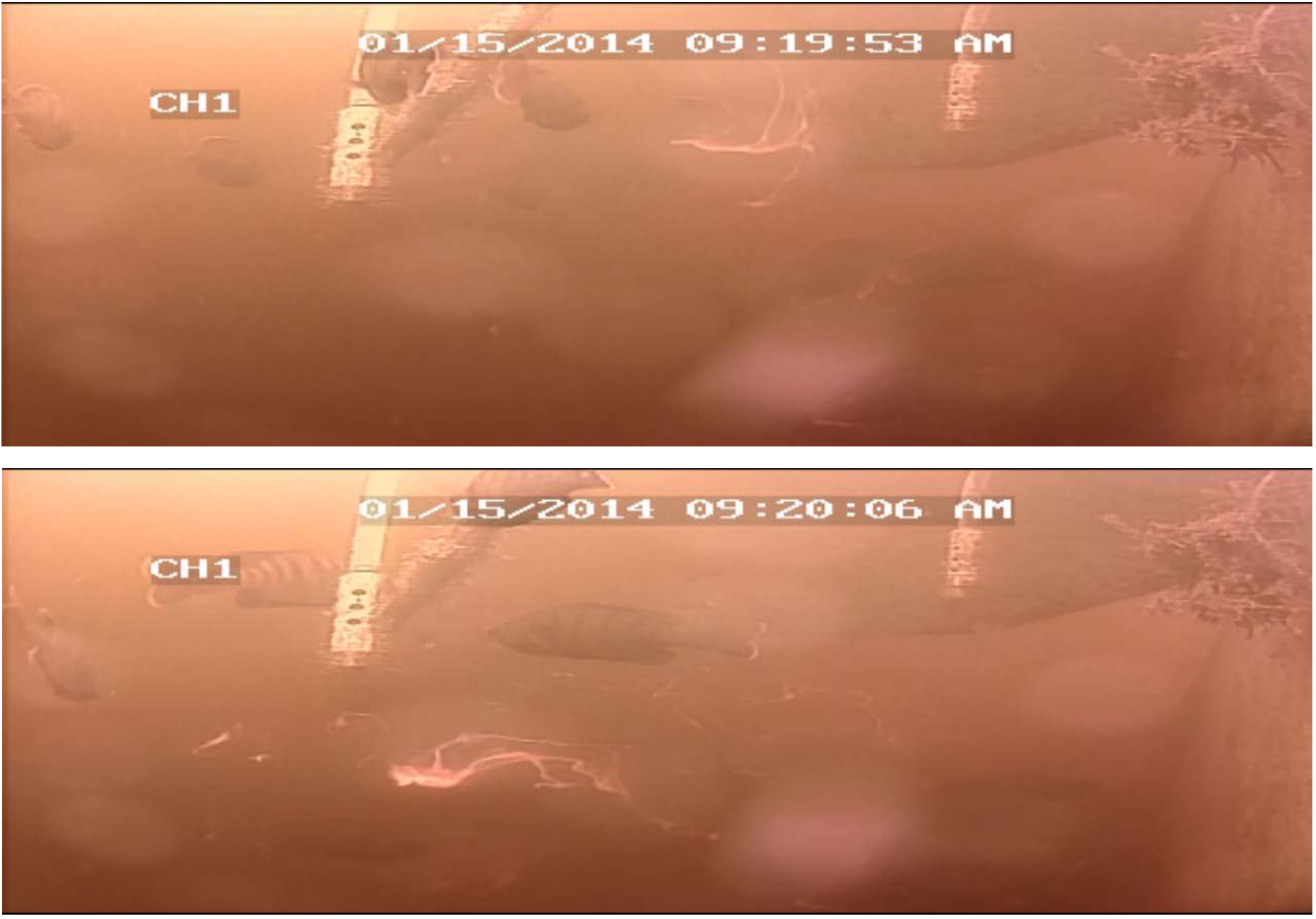


Figure 10. A progression showing the accumulation and removal of bird feces over one day.

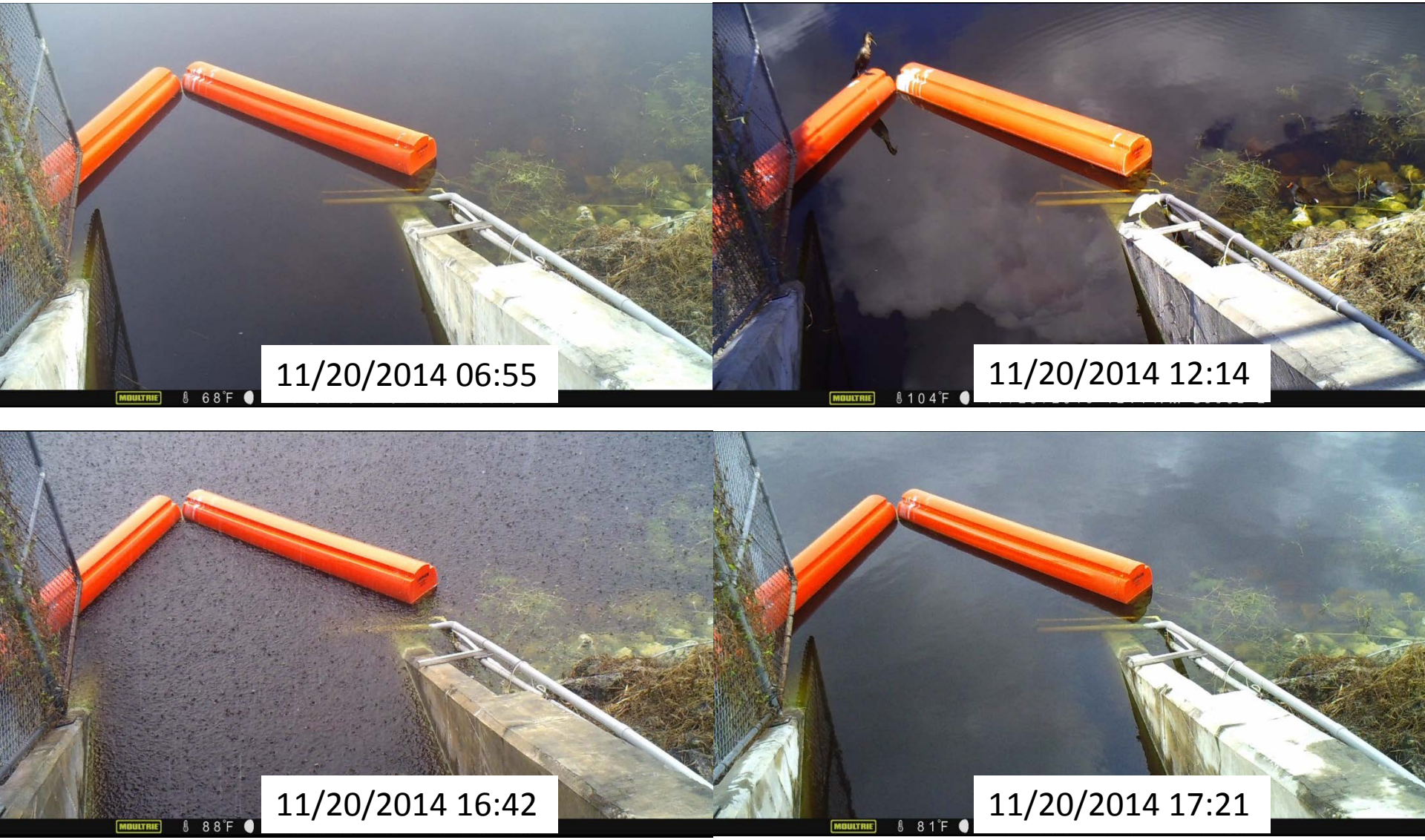
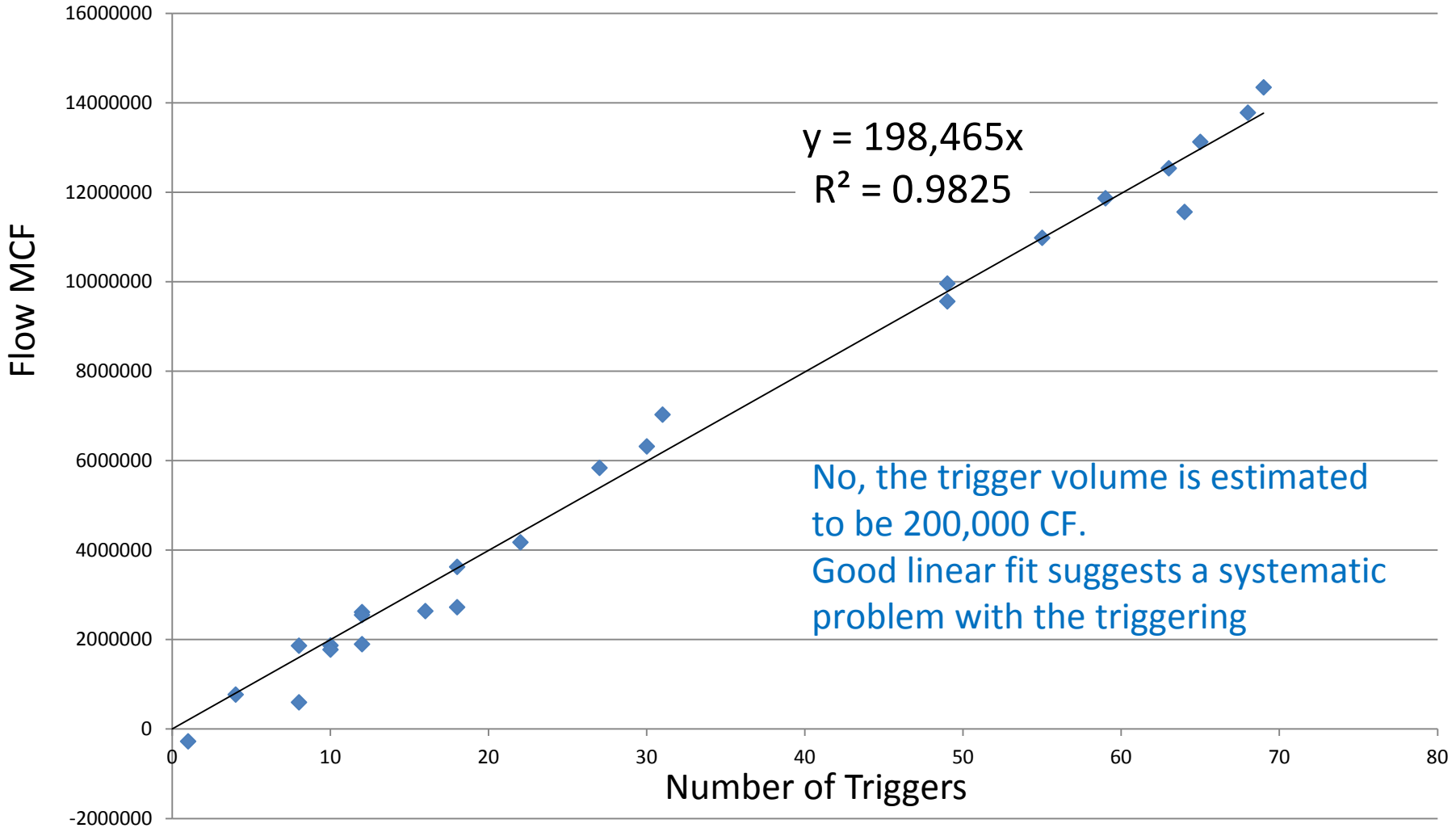


Figure 11. Ashy material from underneath the structure caught in the eddy.

Validating the Trigger Volume

Was G390B ACF functioning properly?
Expected trigger volume= 312,000 CF



G390B ACF Trigger Volume Issue

- ACF supposedly set to trigger at 312,000 CF
- ACF appears to trigger around 200,000 CF
- G390B structure modified in October 2011
  - Original size 6 ft x 6 ft square, now a 36 inch round
  - New flow equation created
    - DBHYDRO flow based on new equation
    - **Never applied to ACF Totalizer**
- New trigger volume based on new size of structure should have been 73,000 CF
  - **Not calculated or applied to ACF totalizer**

Validating the Trigger Volume

Was the G390B ACF flow proportional?

- In terms of accuracy for triggering, the true value should have been 73,000 CF not 200,000 CF or the programmed 312,000 CF
- In terms of triggering precision, variability around 200,000 CF was induced by negative flows and phantom flows
- Not accurate, not precise, but the triggers were proportional to a flow volume

Conclusions for G390B and G310

- ADTs and Grab samples performed as designed
  - Fewer opportunities for systematic error
- G310 ACF did not meet expectations based on time or flow
- G390B appeared to meet expectations, but programming error essentially negates this
- At G390B, negative flow, low flow, and phantom flow all impact flow proportionality (magnitude unknown)
- Counter-position: As long as the ACF has some semblance of flow proportionality the data can be used

ACF data needs to be understood better

- Negative, Low and Phantom Flows may represent a significant amount of the temporal data, but only represent a small amount of the flow
  - It might be possible to ignore these flows entirely and have little to no impact on flow weighted means
- However,
  - Such flows can skew timing and number of samples within a day, week, and even subsequent weeks
  - The magnitude and impact of these are masked by use of mean daily flow data
  - Phantom flows create samples where none should exist (false positives)
    - For G390B 7 out of 34 = 20%
- How accurate does flow proportionality have to be ?

Conclusions and Recommendations from Efficacy Evaluation

- ACF flow triggers should be routinely validated
- ACF completeness targets might be more appropriately calculated based on flow
- Structures with negative flows and phantom flows are problematic
  - ACFs at such structures do not have the same data integrity as structures that lack these concerns
  - The use of ACFs at such structures is not recommended without physical improvements

Can these problems be fixed?

- In general
  - The review of the low flow data and setting some flows to 0 was a fix to correct for phantom flows in the flow database.
    - This isn't and can't be transferred to the totalizer, unless it is done in real time
  - Negative and phantom flows can only be stopped if structure is closed
- At G390B
  - Finally reprogrammed

Summary of Key Qualitative Observations

- SAV may act as a contaminant in the autosampler, it may also act as a filter, possibly dependent on age and condition of the mass
- Fish may be unquantifiable problems
- Turtles are an obvious problems
- Birds are serious problems, exacerbated by infrastructure
- Structures act as attractive nuisances for wildlife (insects, wading birds, vultures)

Extrapolation

- Sampling equipment, structures, and levees are potential sources of TP
  - Wildlife attractor/corridor/nest
  - Levee vegetation mines TP and puts it back into the water column through runoff
  - Levee material itself contains TP
- Reflected in transect results reported by DB Labs

What is the potential magnitude of the problem?

- Wading bird feces in Everglades have TP concentrations ranging from 21-57 g/Kg (Irick et al., 2015)
- Runoff from control plots in Bermuda Grass stabilization studies of LA levees exceeded 50 ug/L and ranged up to 2,000 ug/L (Burwell et al., 2011)
- It might be necessary to add levee processes and contributions to the conceptual models

Questions?