Suburban Case Study: Flatlick Branch (Fairfax, VA) Stream Restoration Project

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Department of Public Works and Environmental Services
Working for You!

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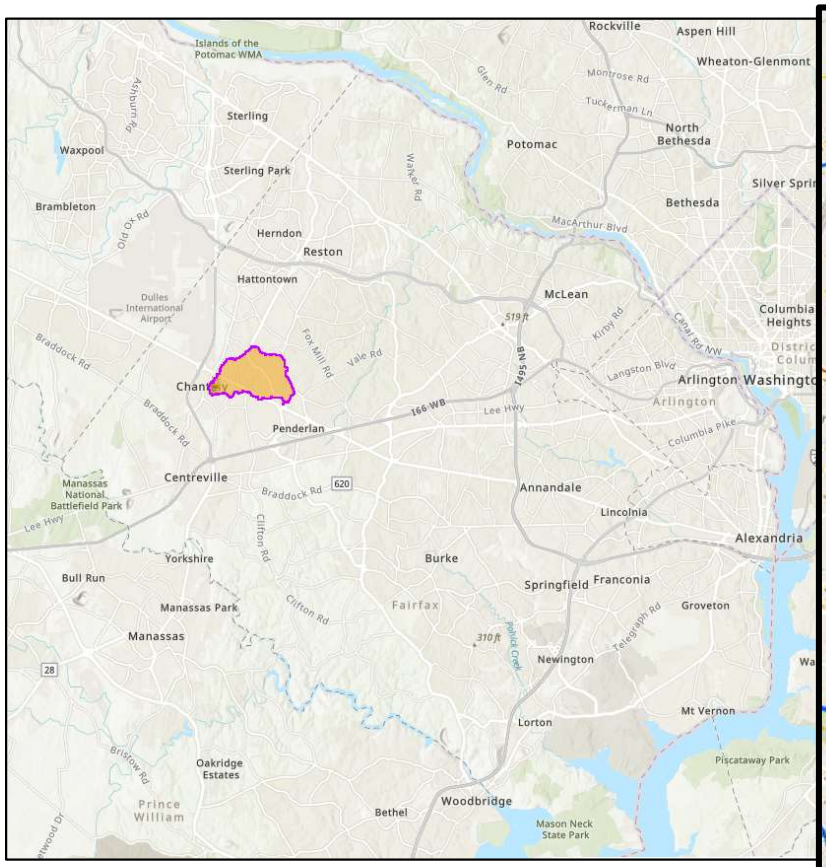
Outline

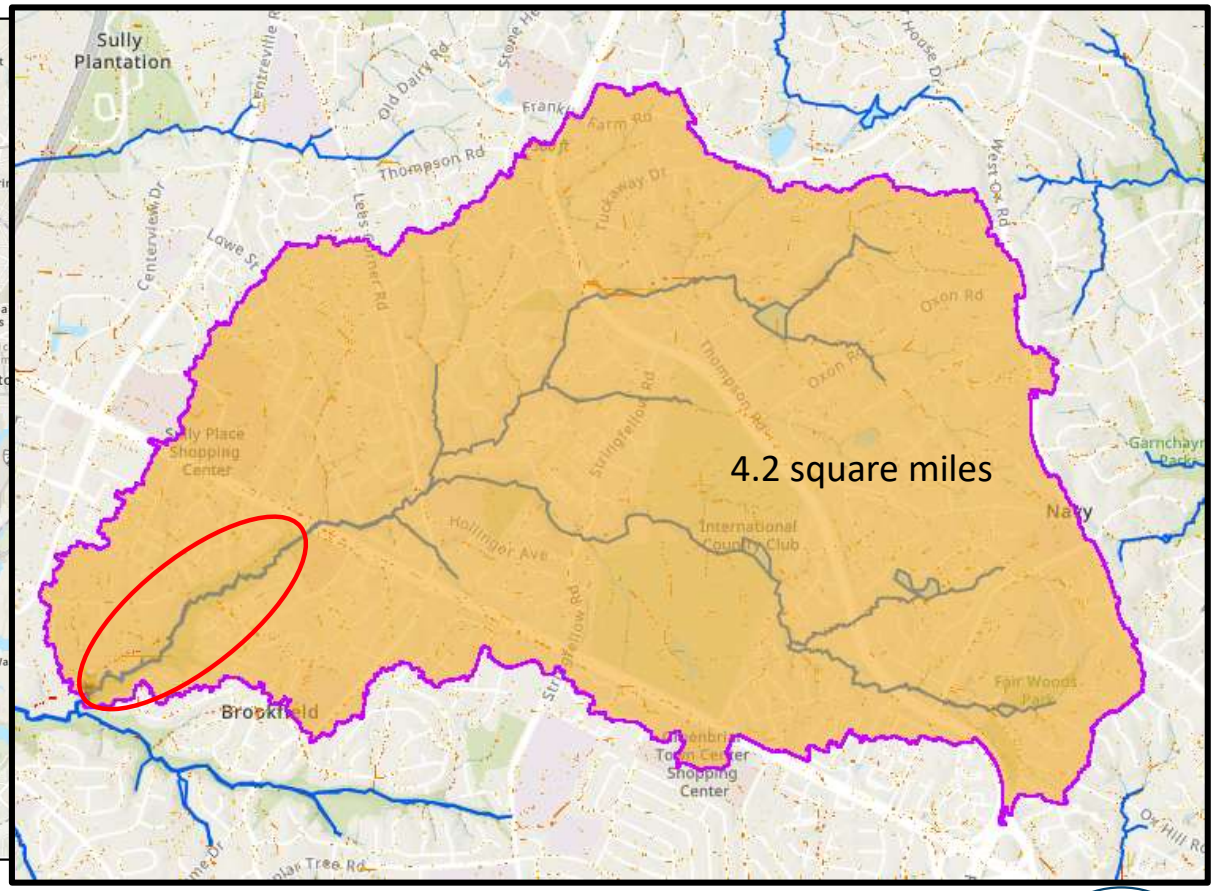
- Landscape setting & impairments
- Regulatory & policy drivers
- Goals
- Design approach / practices used
- Monitoring – **this is very different from most!**
- Outcomes & applicability to future work

Thanks:

- Neely Law (Fairfax County)
- Aaron Porter (USGS)
- Fairfax County ecologists

Flatlick Branch Watershed, Fairfax County, VA



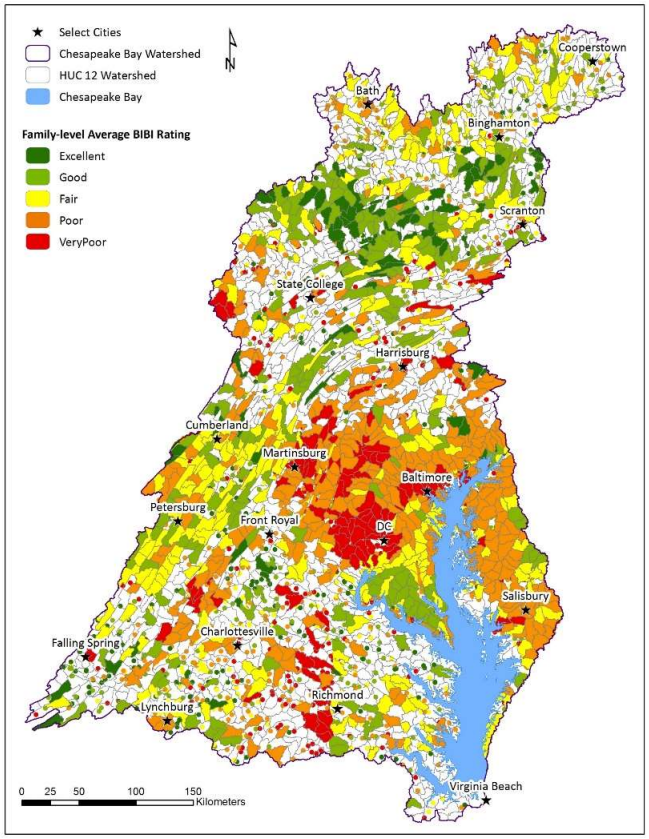


Flatlick Stream Restoration – Post-restoration aerial image

Regulatory Policy & Restoration Drivers

Desired/Regulated Outcomes

- Water quality improvement – Ches Bay TMDL
  - Nitrogen, phosphorus and sediment reduction targets
  - Stream restoration is a key management action to reduce nutrient loads in the agricultural and urban land use sectors
- Continually improve *stream health and function* throughout the watershed.
  - Not explicitly defined
  - Stream health measured and tracked by the “Chessie BIBI” (Biology)



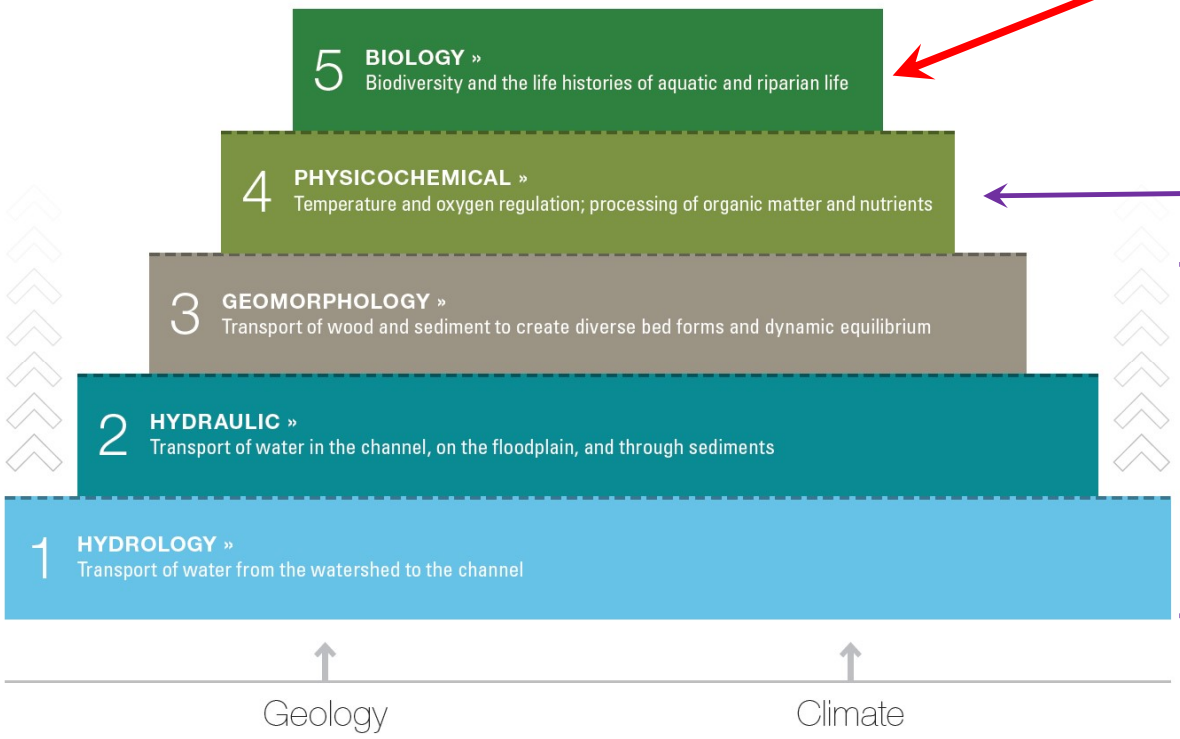
Restoration Goals

1. N, P and Sediment (Ches Bay TMDL)
2. Stability
3. Flood less/more frequently, connect to FP
4. Creation of habitat for biological improvement

Unusual for Fairfax County

- Longer than most projects
- Larger stream (order/size) than typical

Design Approaches & Practices



Hard to control – "these are watershed issues"

Assumed we can control "somewhat" through urban stream restoration

Flatlick Branch Stream Restoration (Phases 1 & 2)

- Stressors Addressed through design
  - Geomorphology & (Sediment)
  - Flow regime
  - Nutrients
- Restoration Length
  - Phase 1 – 1772 lf
  - Phase 2 – 4275 lf
- Phase 1 & 2 are credited with the following reductions (default rate) using Ches Bay Protocols 1 and 2:
  - P – 506 lbs/yr
  - N – 4,221 lbs/yr
  - Sediment – 66.3 tons/yr

Over 1.0 mi

Monitoring

- Ongoing partnership w/ USGS since 2007
- Comprehensive monitoring
  - **Continuous** temp, flow, stage, pH, DO, SPC, and turbidity
  - Every sampling event (below) temp, pH, DO & SPC
  - **Monthly** grabs (N, P, TSS, Turbidity)
  - **Storm collections** (3-6 per year) of N, P, Sediment
  - **Bi-monthly** (Bacteria, Ions)
  - **Annual** benthic macroinvertebrate surveys
  - **Triennial** (every 3rd year) fish monitoring (started 2016)

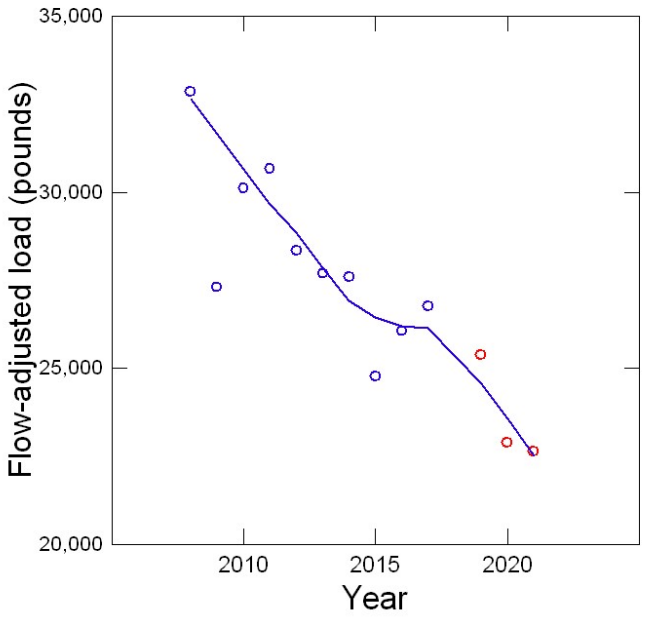
Past regulatory-required monitoring

[USGS Fairfax County, VA Surface Water Monitoring Network]

Flatlick Branch, Goal #1, TMDL Reductions (Total Nitrogen)

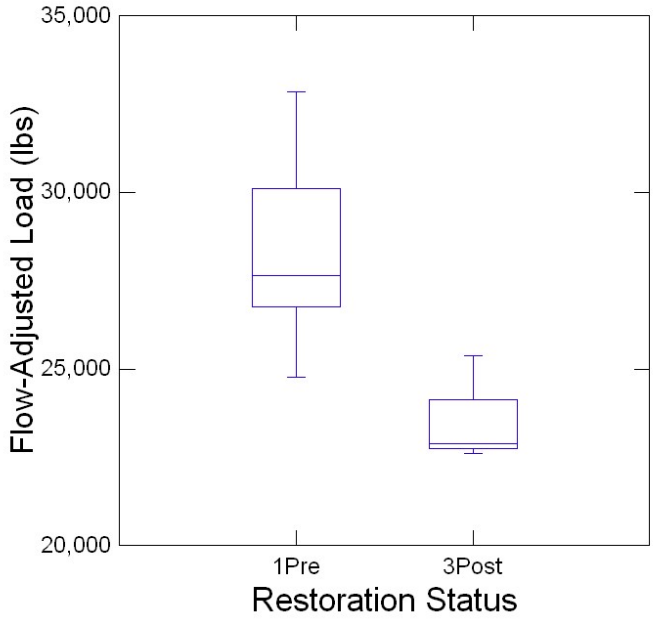
Total Nitrogen = GOAL ACHIEVED

Annual TN Load (2008-2021)



Pre-Restoration / Post-Restoration

Annual TN Load (Pre-Post)



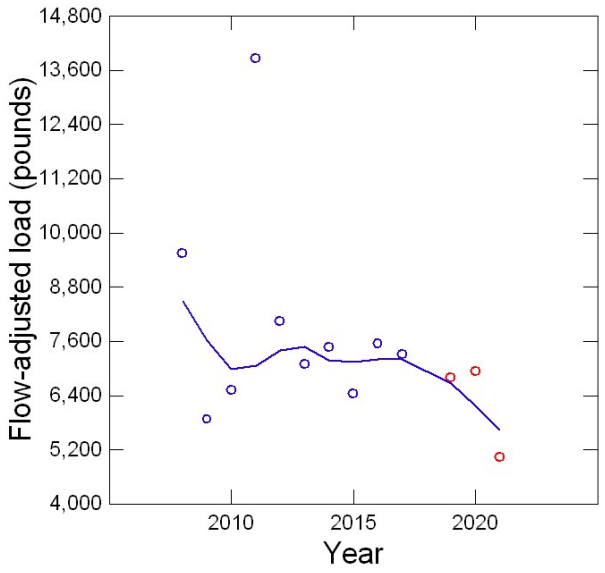
Kolmogorov-Smirnov, p <.0001
Mann-Whitney, p = 0.018

Annual Nitrogen Reduction	Pounds/Yr
Gage Measured (Flow-Adjusted Mean)	4585
TMDL Credited from Restoration	4221
Excess Removed	364

Flatlick Branch – Goal #1, TMDL Reductions (Total Phosphorus)

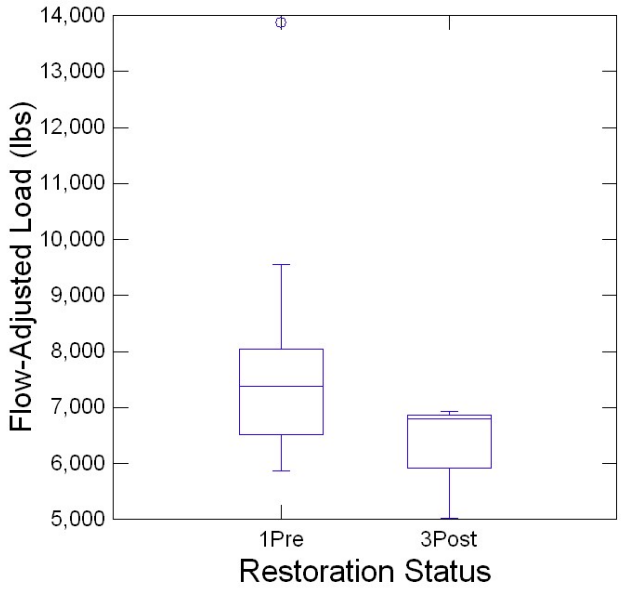
Total Phosphorus = GOAL ACHIEVED

Flow-Adjusted TP Load



Pre-Restoration / **Post-Restoration**

Annual TP Load (Pre-Post)



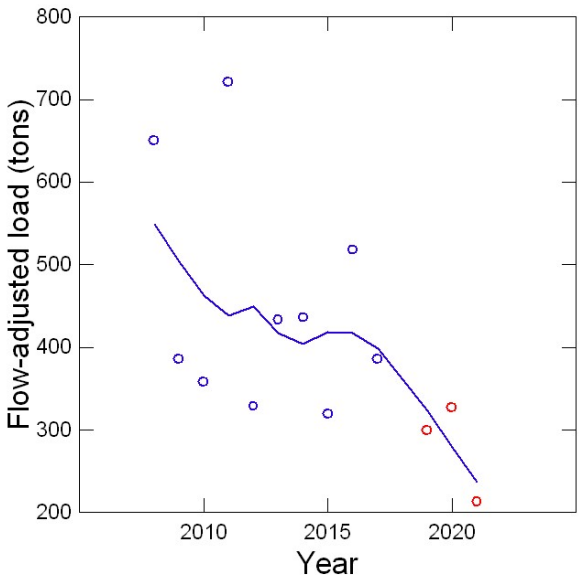
Kolmogorov-Smirnov, p = 0.001
Mann-Whitney, p = 0.128

Annual Phosphorus Reduction	Pounds/Yr
Gage Measured (Flow-Adjusted Mean)	1714
TMDL Credited from Restoration	506
Excess Removed	1208

Flatlick Branch – Goal #1, TMDL Reductions (Total Suspended Sediment)

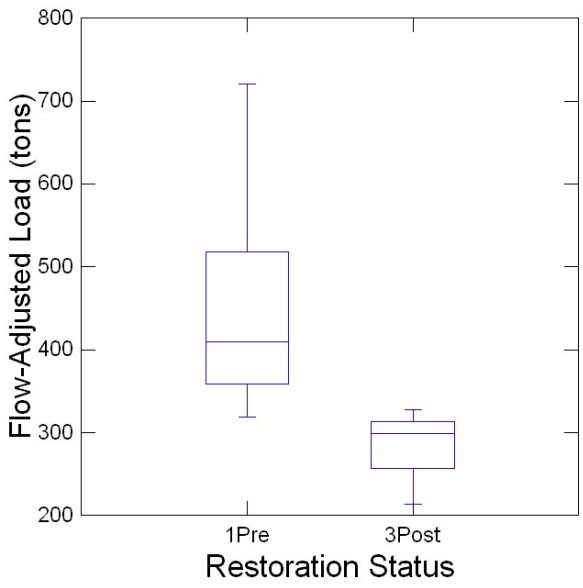
Total Suspended Sediment = GOAL ACHIEVED

Flow-Adjusted Sediment Load



Pre-Restoration / **Post-Restoration**

Annual Sediment Load (Pre-Post)



Kolmogorov-Smirnov, p = 0.020
Mann-Whitney, p = 0.018

Annual Sediment Reduction	Tons/Yr
Gage Measured (Flow-Adjusted Mean)	174
TMDL Credited from Restoration	66
Excess Removed	108

Flatlick Branch – Goal #2, Stability

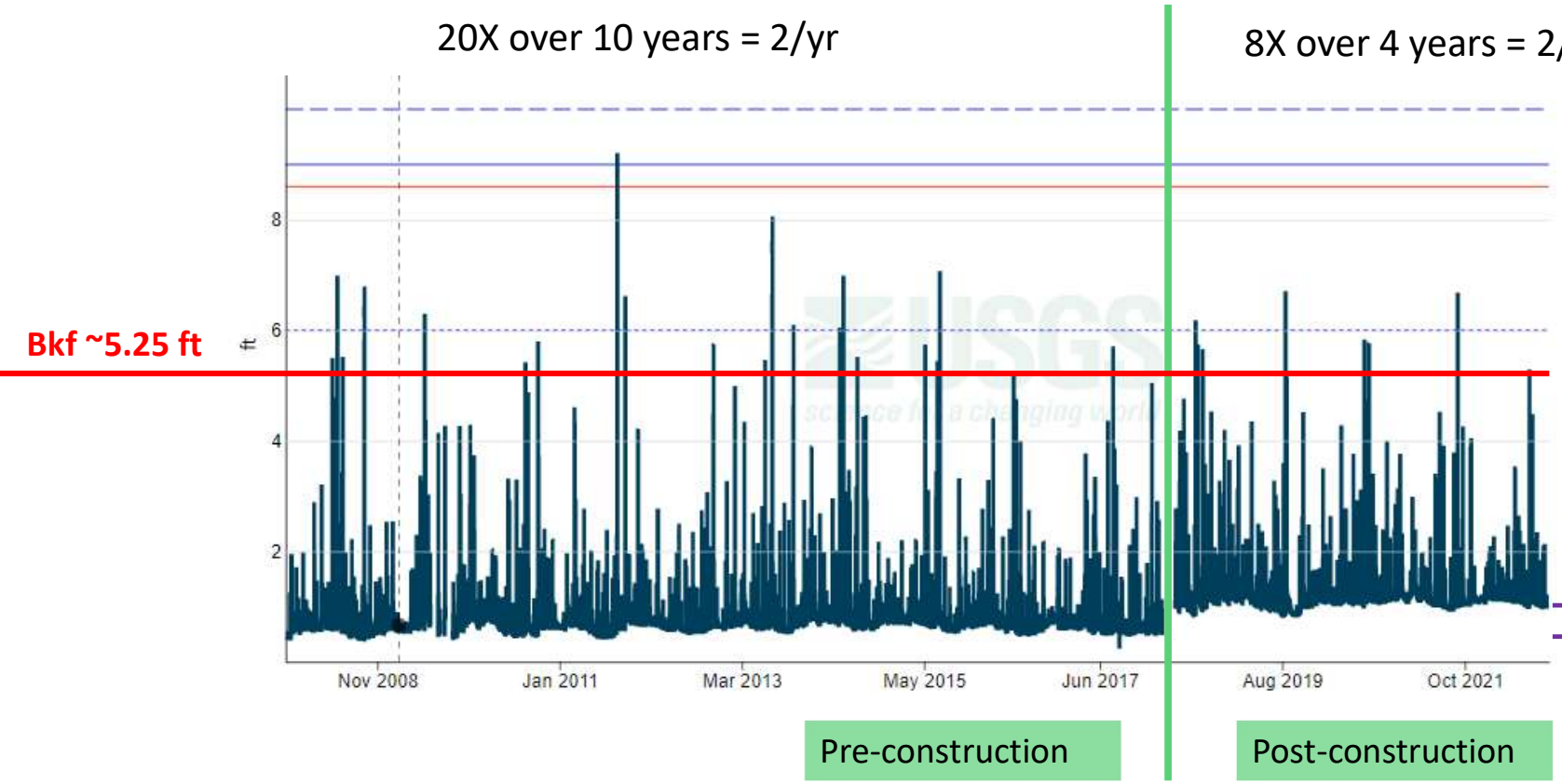
Stability = GOAL ACHIEVED

1. Maintain annual credits
2. Reduce maintenance / corrective action
3. 5-yr inspection cycle

POST – 1st summer

POST – 3rd winter

Flatlick Branch – Goal #3 - Floodplain connectivity

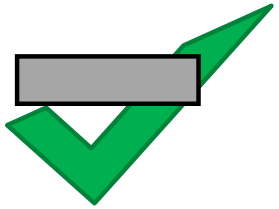


FP Connection= GOAL ACHIEVED

Raised streambed, widened stream

Flatlick Branch – Goal #4, Habitat and Biological Improvements

RBP Habitat = GOAL ***MAYBE*** ACHIEVED?



Modified from EPA's Rapid Bioassessment Protocol (RBP)

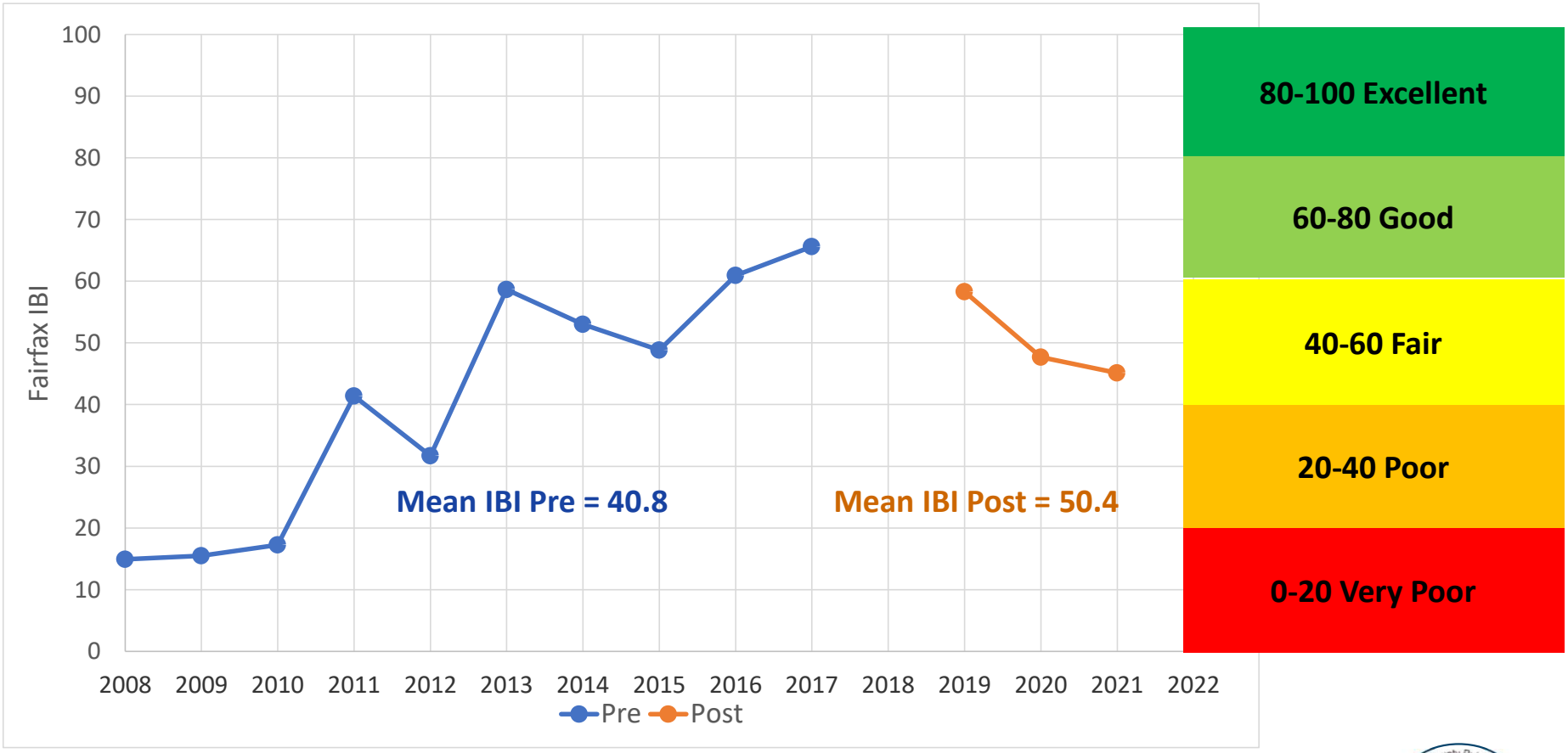
10 metrics, 0-20 scale

Semi-quantitative

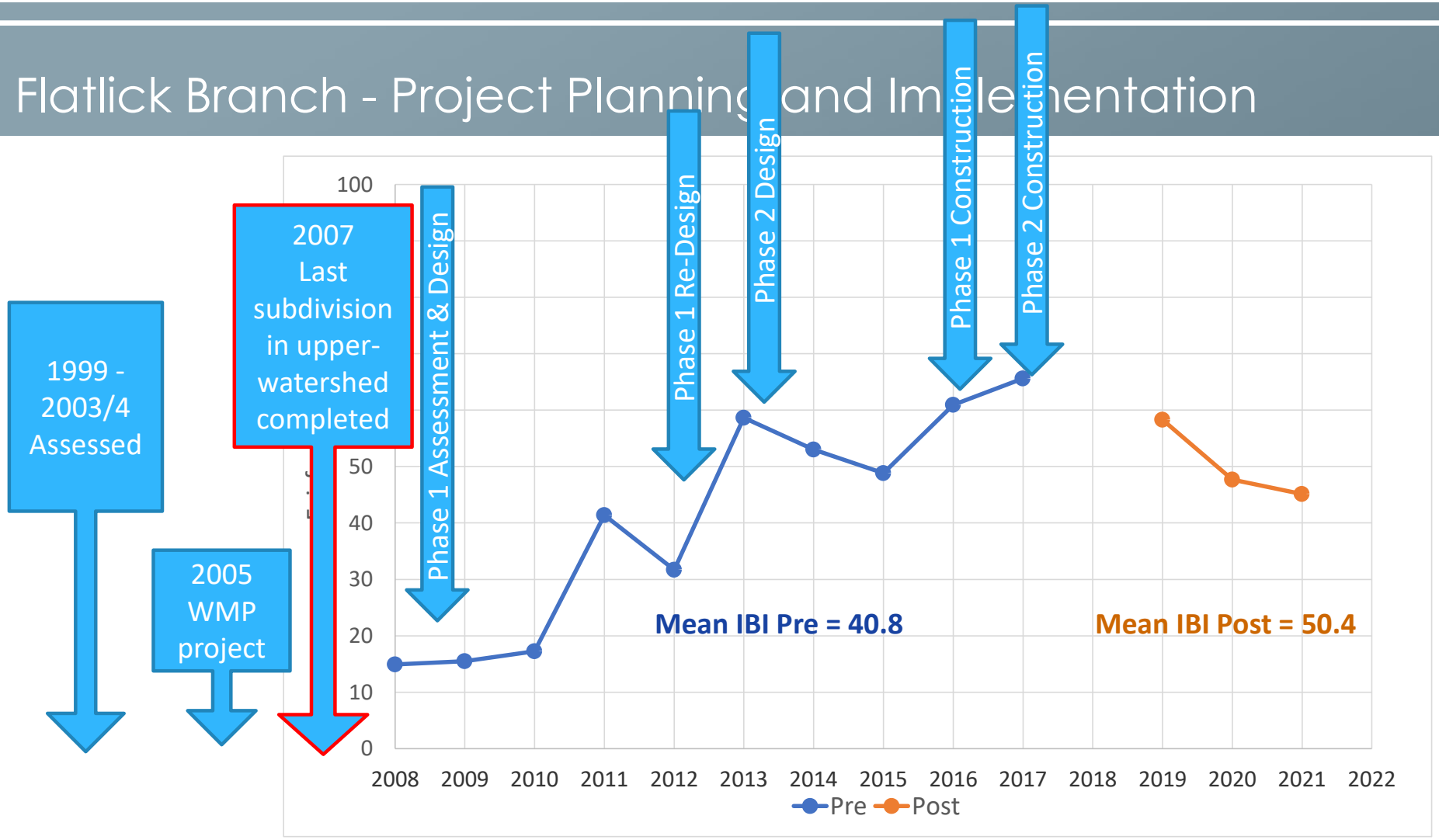
Goal of "improve habitat to support biology" assumes if you build it...

RBP Metric	Trend
Total Habitat Score	↑
Epifaunal Substrate / Available Cover	↑
Sedimentation (In-Channel Deposits)	↑
Bank Stability	↑
Channel Alteration (Man-Made Alteration)	↓
Velocity/Depth Regime (Flow Variability)	↓

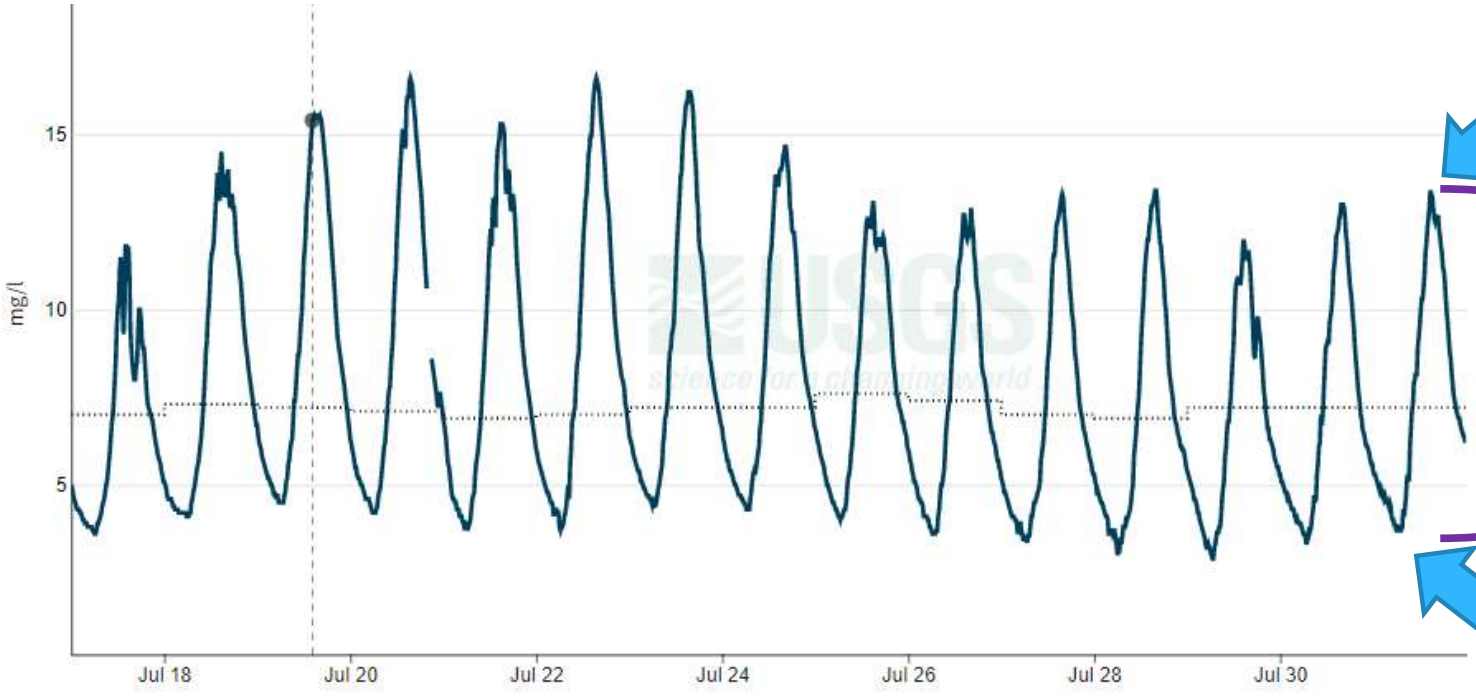
Flatlick Branch – Benthic Macroinvertebrate Assemblage



Flatlick Branch - Project Planning and Implementation



Diurnal cycle of dissolved oxygen



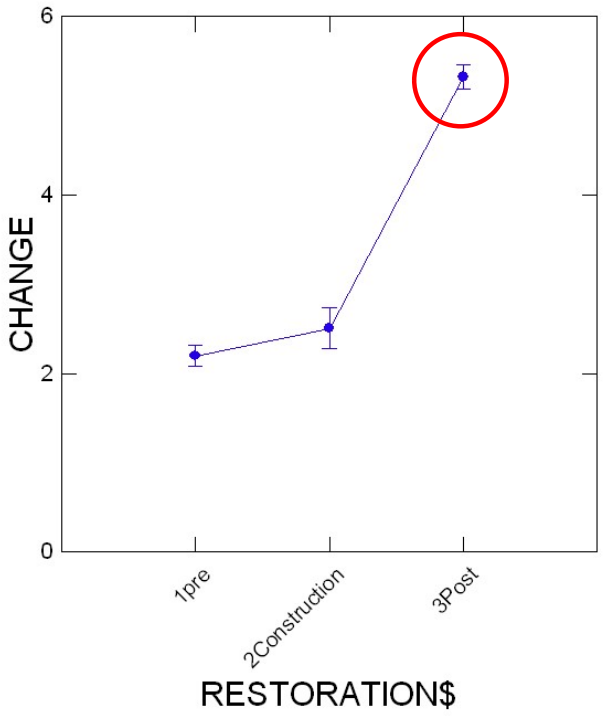
Peak photosynthetic activity minus active respiration

Daily shift in DO from ~4mg/L to ~13.5 mg/L

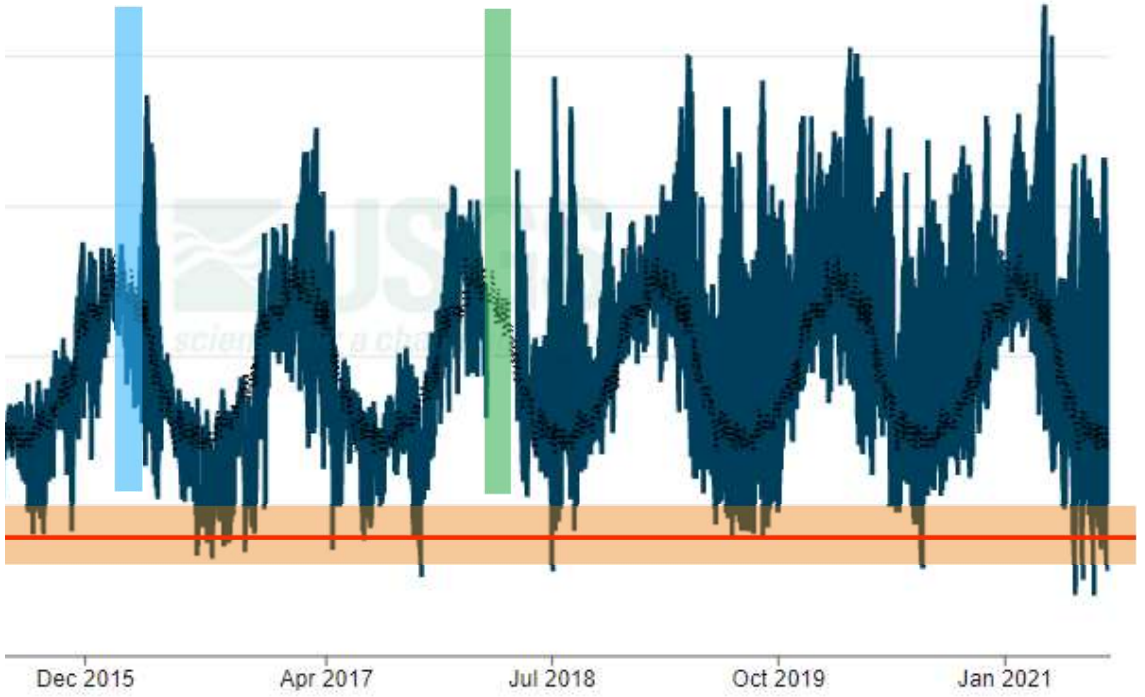
Respiration only, no photosynthetic activity

Dissolved Oxygen – large diurnal changes in DO (mg/L)

Significant increase in daily DO fluctuation (ANOVA, $p < 0.001$)

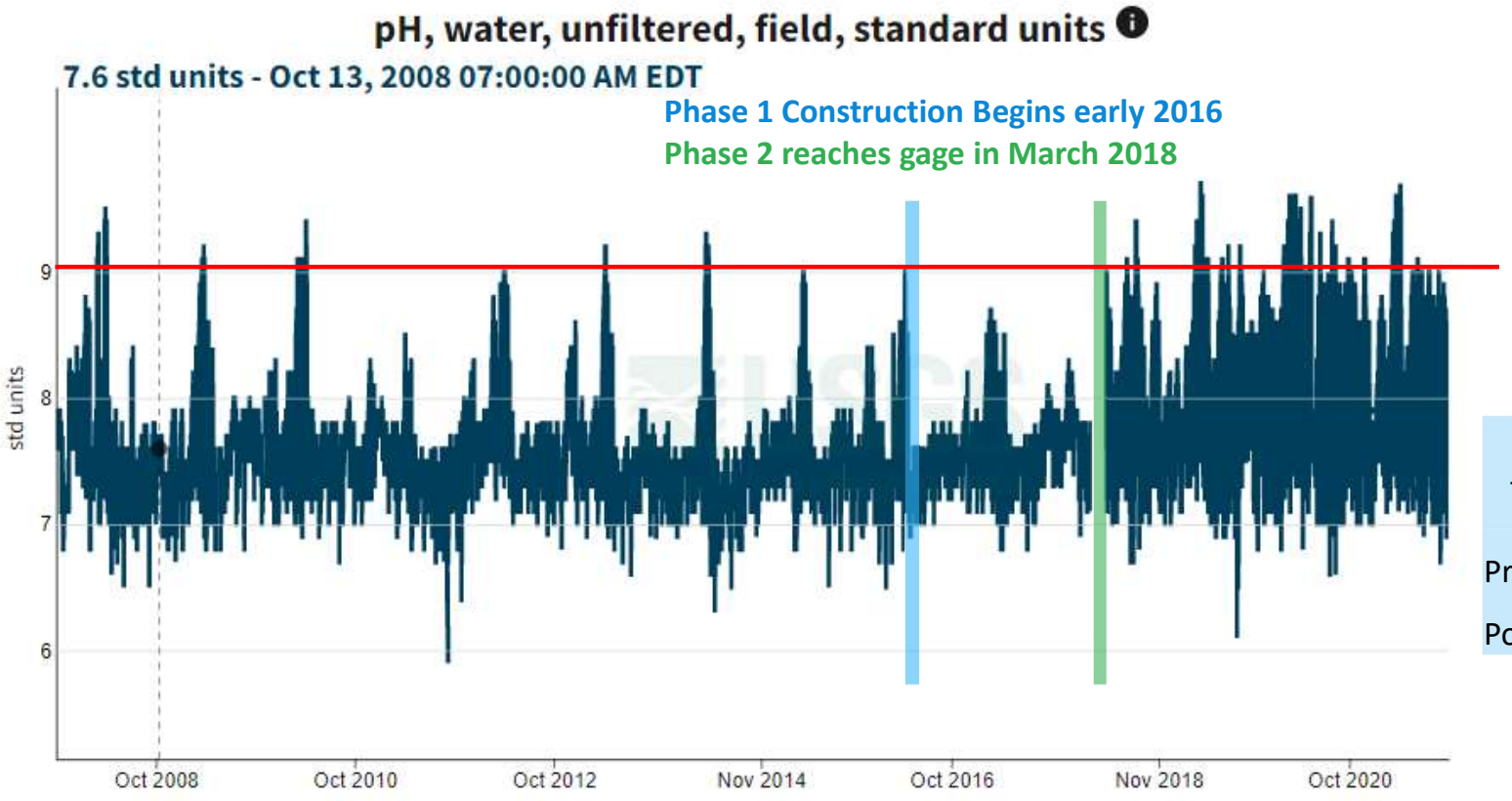


Phase 1 Construction Begins early 2016
Phase 2 reaches gage in March 2018



State Std 4mg/L

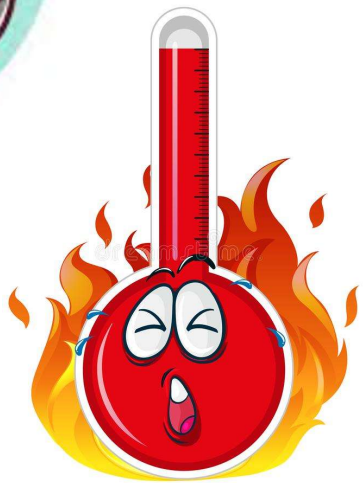
pH



State Std
pH = 9.0

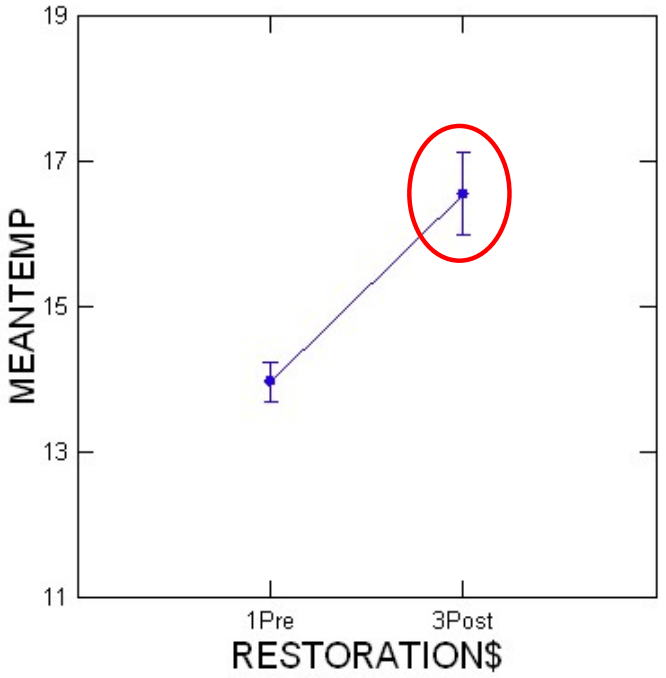
Exceedances (pH > 9.0)	N	Percentage of Days
Pre-Restoration	34	0.93%
Post-Restoration	112	10.23%

Changes in Stream Temperature (Pre- and Post-Construction)



Dulles Airport mean daily Air Temp increased 0.6 deg C over the same period

Over 2.5 deg C increase in the mean daily stream temperature (ANOVA, p<0.001)



Stream Temperature – Max Temps, shifting baselines

Pre-construction (2007-2017)

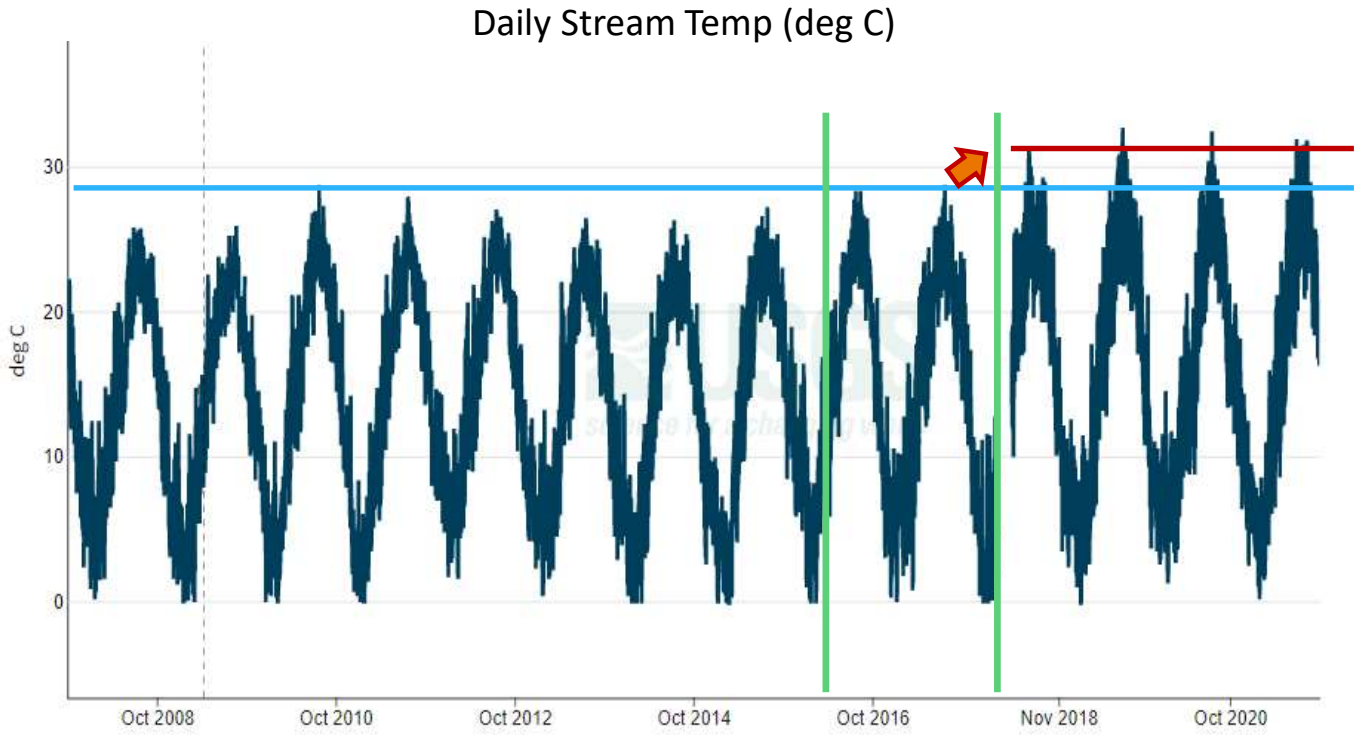
- Daily Max Temp: 28.7 deg C
- That's 83.7 Fahrenheit!!!

Post-Construction (2018-Sept 2021)

- Daily Max Temp: 32.7 deg C

  State Std 32 deg C

- Exceeded 28.7 deg C = **105 times**
- Exceeded 30.0 deg C = **41 times**



Stressors - Fish Thermal Tolerance/Restoration Response

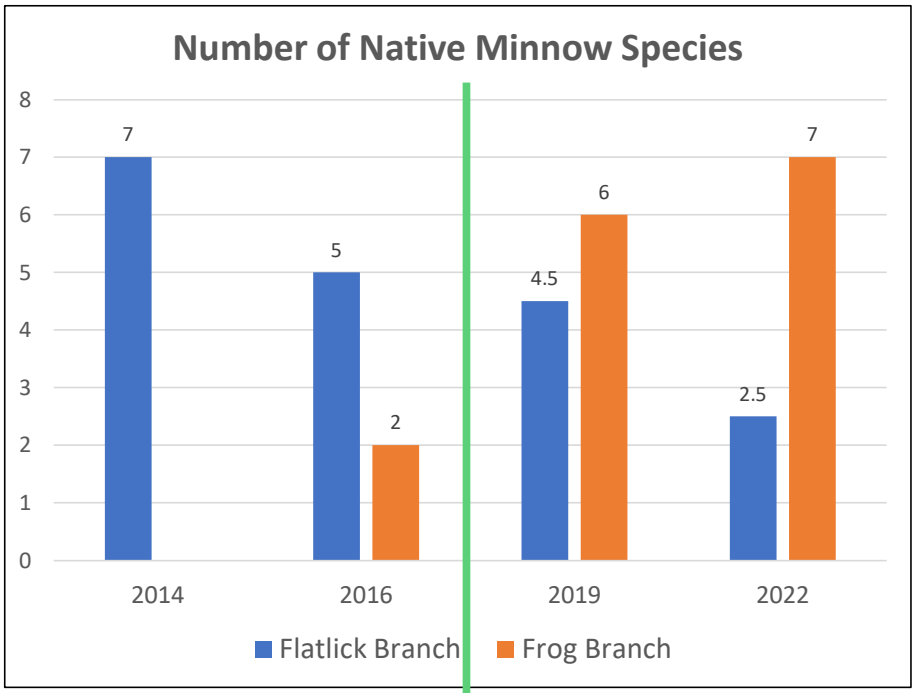
Physiochemical Stressors for Fish (measured on most water quality sondes)

- DO
- pH
- Conductivity (TDS)
- **Temperature**

Each species has different tolerances for each of these stressors These can change with life stage (egg, juvenile, adult, etc.)

Many minnows with a native range in Fairfax, Virginia have thermal tolerance at 28-30 deg C

Fish Assemblages (restoration reach and adjacent stream)



Pre-construction

Post-construction

Shift in fish assemblage

Median Percent Abundance in Fish Families

	Centrarchidae (Sunfishes)			Cyprinidae (Minnows)		
Stream	Pre	Post	Trend	Pre	Post	Trend
Flatlick Branch	39.0%	65.4%	⇧	34.8%	5.7%	⇩
Frog Branch*	4.7%	21.3%	⇧	92.3%	63.3%	⇩

Sunfishes

Minnows

Restoration Outcomes

Restoration Goal	Measurable	Outcomes
1. Credits toward Chesapeake Bay TMDL	Nitrogen	↑
	Phosphorus	↑
	Total Suspended Sediment	↑
2. Stability	repeated visual inspections	↑
3. Floodplain connectivity	USGS stage data	↑
4. Habitat for biological recovery	RBP habitat metrics	▭ ↑
Other - Physiochemical	Temperature	↓
	Conductivity	▭
	pH	↓
	Dissolved Oxygen	↓
Other - Biology	Benthic macroinvertebrates	▭ ↓
	Fish assemblage	↓

Where we are…

- Lag times from project identification to completion affect outcomes
- Management practices that focus on singular impairments/sources/stressor may limit holistic restoration outcomes
  - Multiple stressors impacting stream health
- Regulatory and non-regulatory drivers of stream restoration impact restoration approach
- Need for robust monitoring, particularly linked expected restoration outcomes
- Modifying stream ecosystems require trade-offs limiting or delaying lift

<u>Next steps</u>

- Add stressors/factors to monitor or add to analyses (suggestions?)
- Investigate specific metrics, indicator species, and community analyses
- Dive into life history data regarding key critters (fish, benthics, others?)

Additional Information

For additional information, please contact

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www.fairfaxcounty.gov/environment-energy-coordination

Reference Site IBIs 2004-2021 (by Physiographic Province)