INTENSIVE SAMPLING DURING STORM EVENTS TO IDENTIFY LAND-BASED SOURCES OF FECAL CONTAMINATION TO A COASTAL ESTUARY

A CASE STUDY FROM PARSONS CREEK

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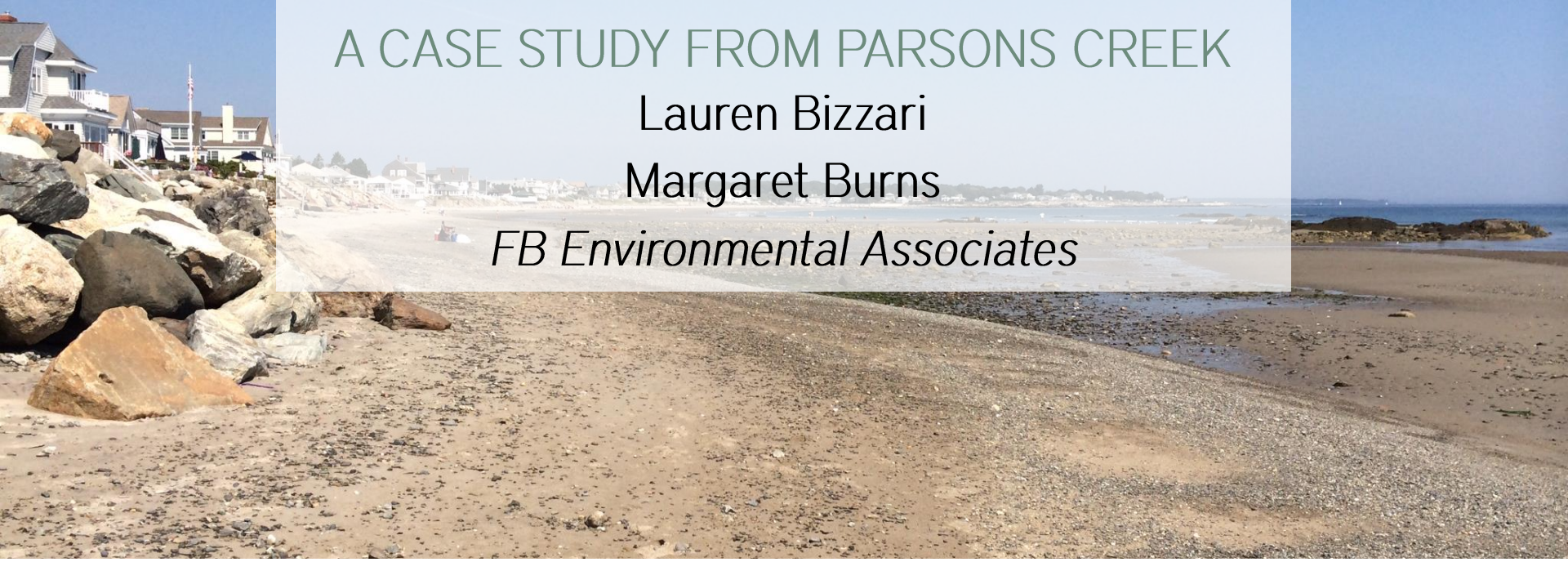


2017 Maine Sustainability and Water Conference
March 30, 2017

97A Exchange
Street Suite 305
Portland, Maine
04101

FB environmental

Surface water impairment for fecal matter/ bacteria

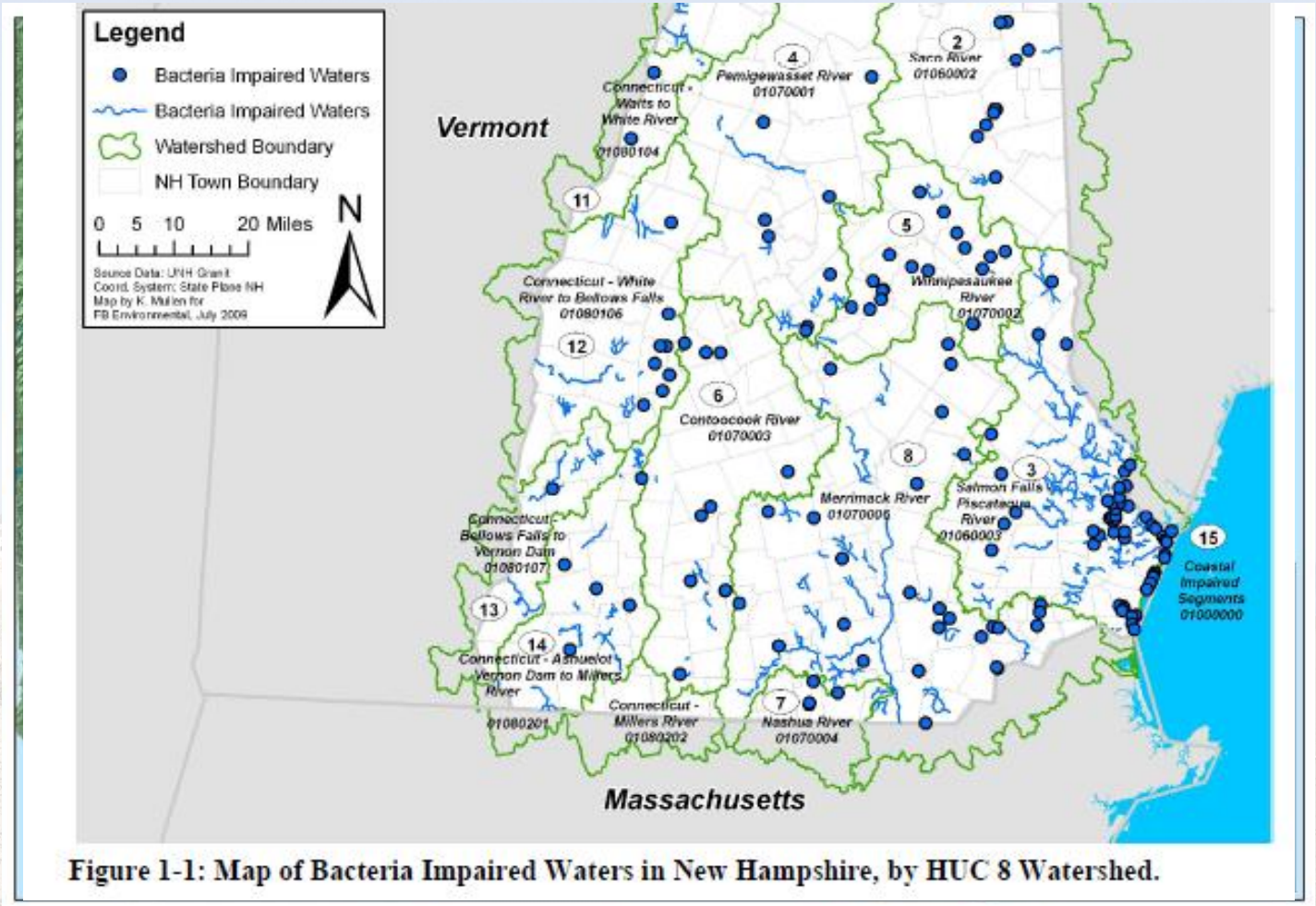


Figure 1-1: Map of Bacteria Impaired Waters in New Hampshire, by HUC 8 Watershed.

Bacteria used as indicator of fecal contamination (e.g., FIB)

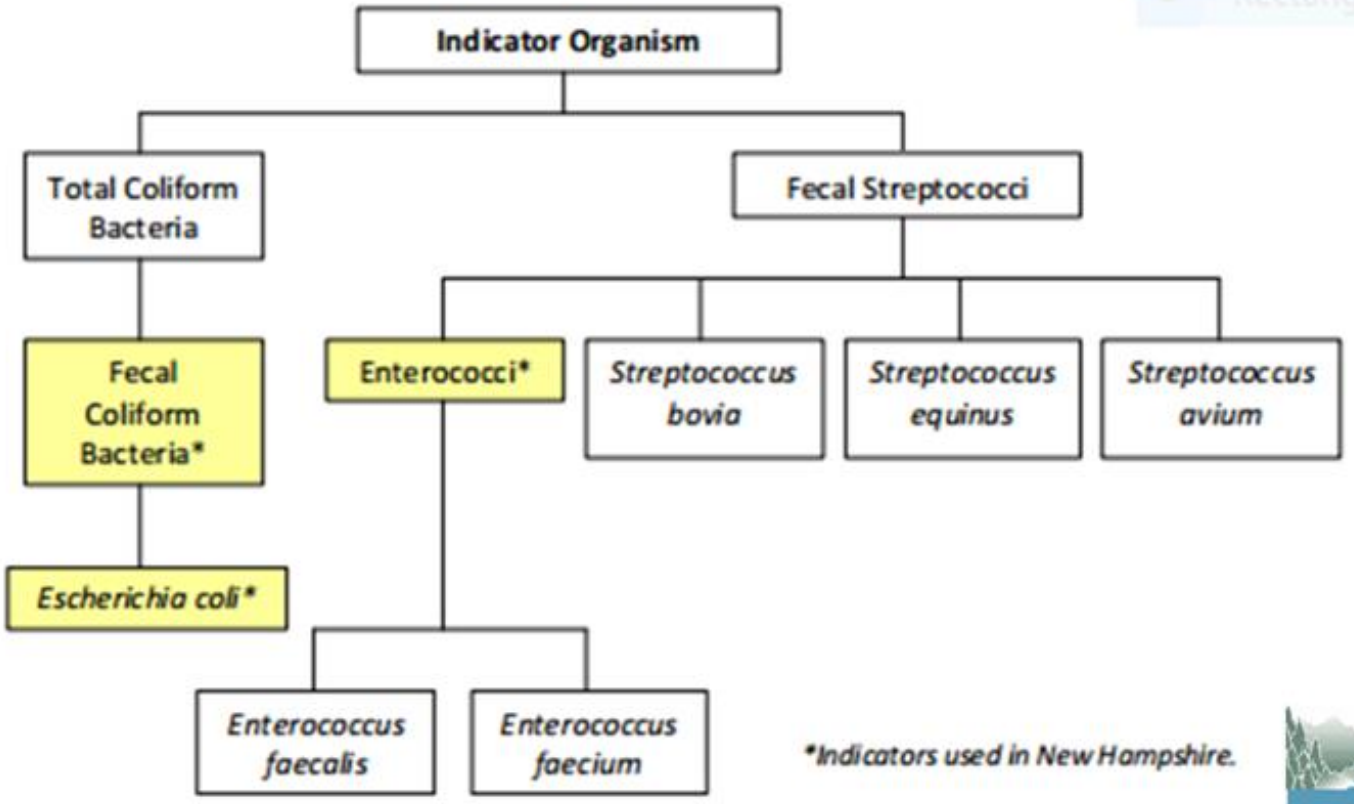
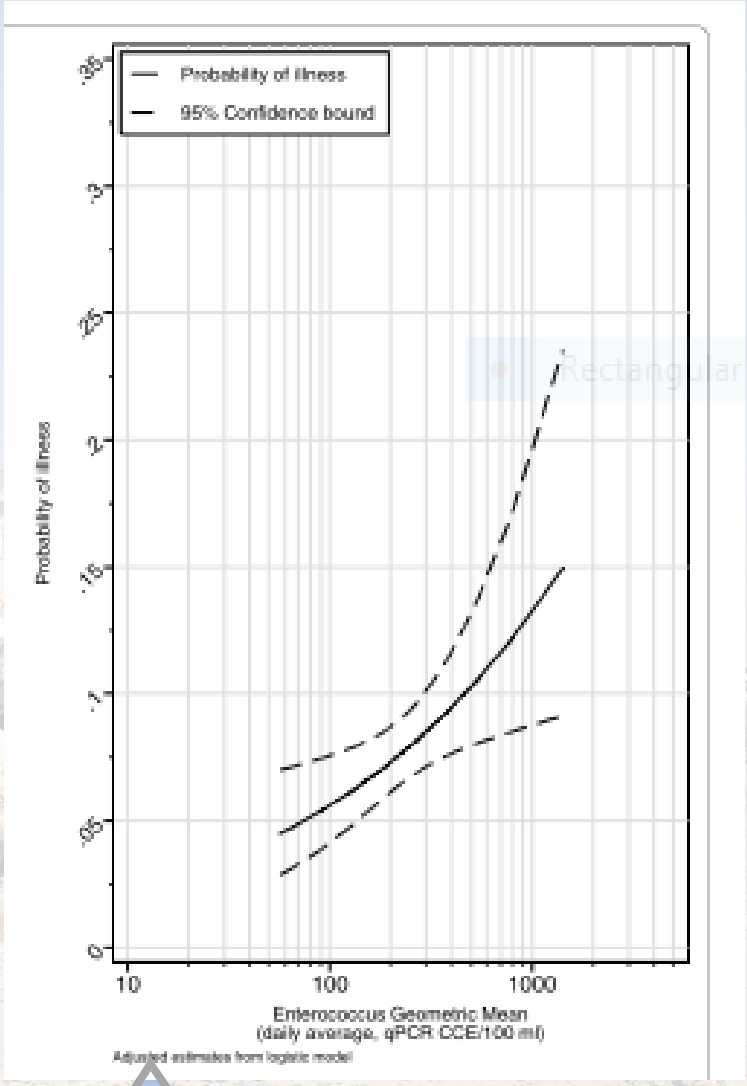


Figure 2-1: Relationship among Indicator Organisms (USEPA, 2001).



WHY SHOULD WE CARE ABOUT FIB?

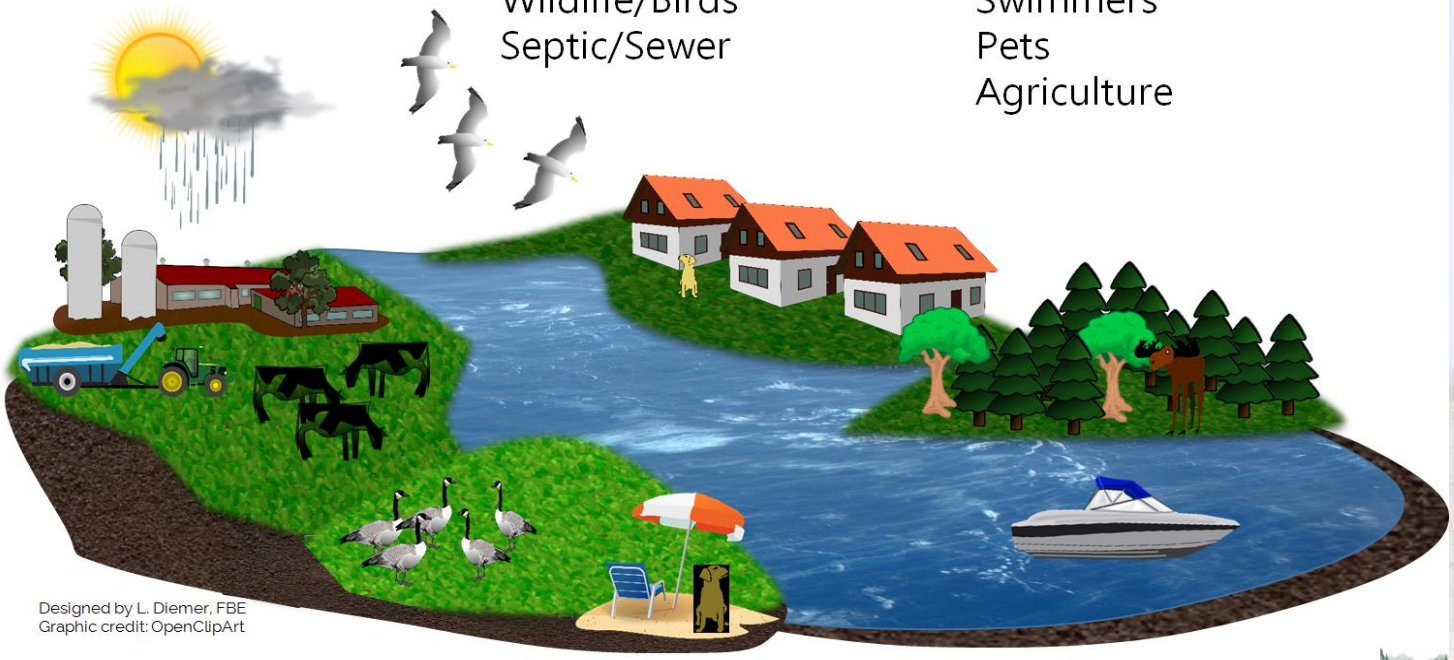
- Indicator of human health risk
- GI illness correlated to *Enterococci*
- Pathogens cause illness

Wade et al. 2010

SOURCES OF FECAL INDICATOR BACTERIA

Stormwater runoff
Wildlife/Birds
Septic/Sewer

Overboard discharge
Swimmers
Pets
Agriculture

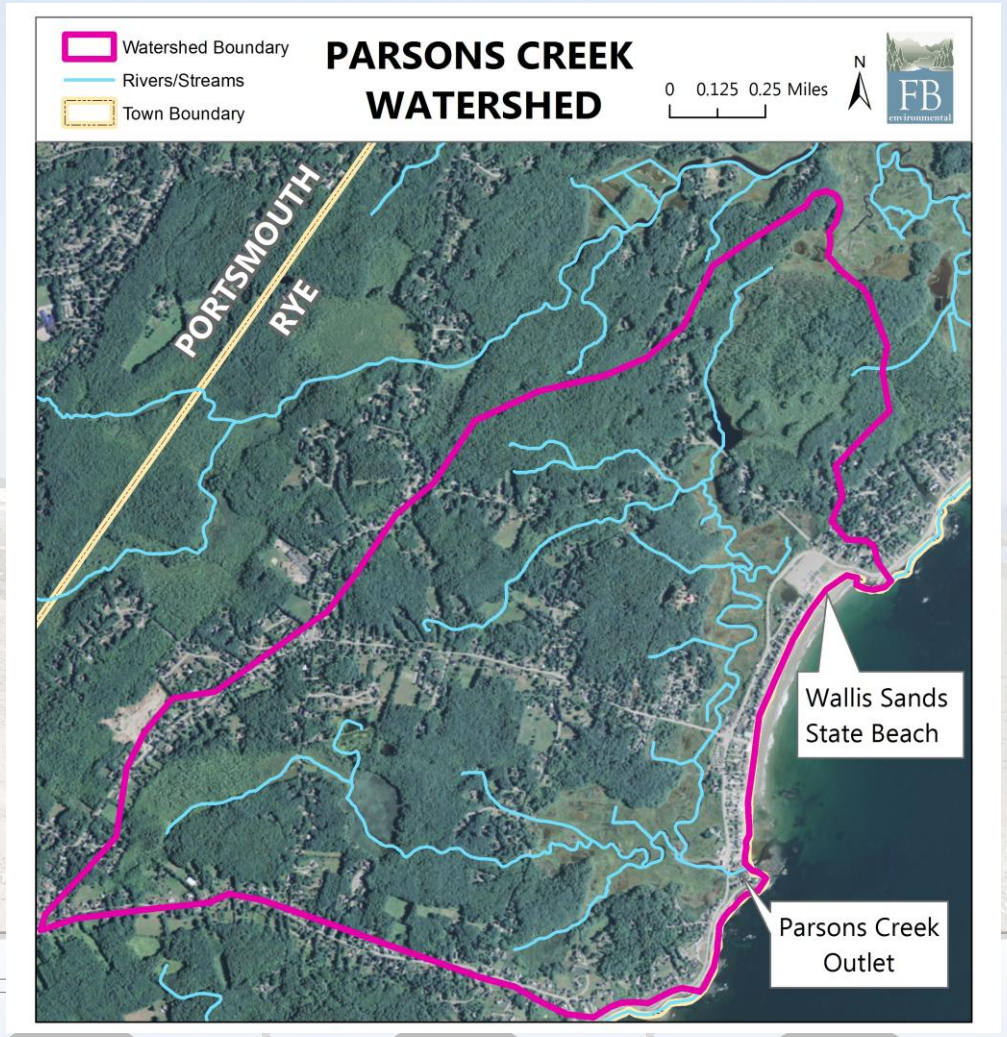


Designed by L. Diemer, FBE
Graphic credit: OpenClipArt

CASE STUDY: PARSONS CREEK

- Impaired for Primary Contact Recreation (fecal indicator bacteria - FIB)

- Since 2008: track and manage FIB sources
  - Beach sampling (seeps)
  - Creek outlet and watershed investigations



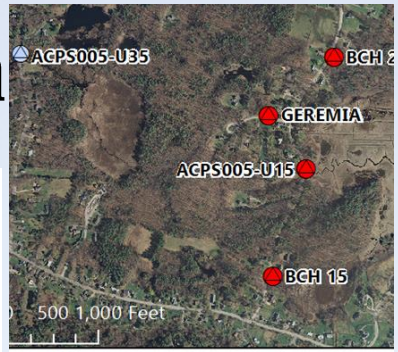
PARSONS CREEK – Historical Data

- Majority of watershed sites exceeded criteria
- Consistent issue for Parsons Creek
- FIB levels dependent on weather conditions; no trends over time

Many families play in tide pools near the outlet of Parsons Creek. Fecal contamination coming from the watershed poses a threat to public health. Photo Credit: FBE.

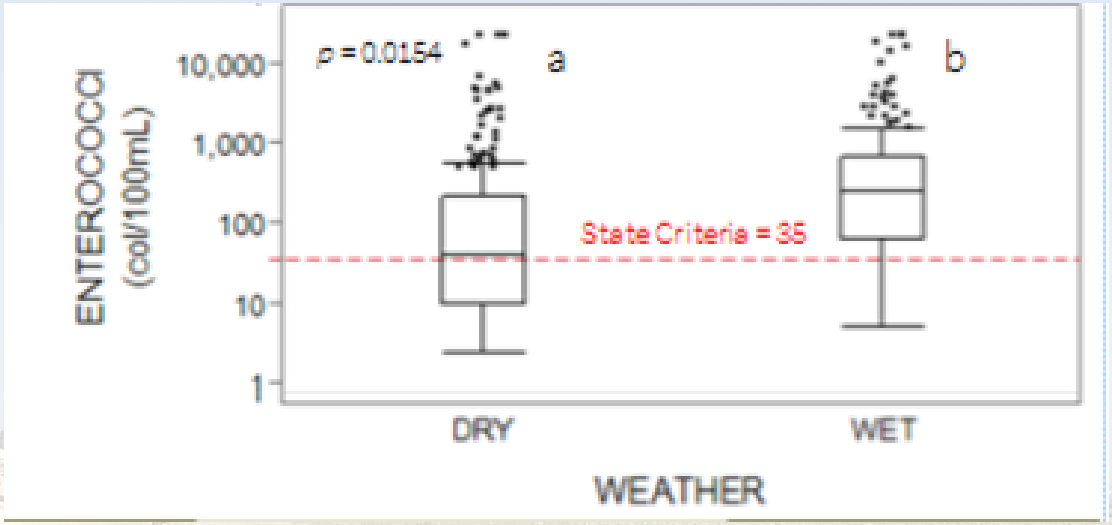
MAP LEGEND

- E. coli (Meets Criteria)
- E. coli (Exceeds Criteria)
- Enterococci (Meets Criteria)
- Enterococci (Exceeds Criteria)
- Fecal coliform (Exceeds Criteria



BACKGROUND & GOALS | METHODOLOGY | RESULTS | CONCLUSIONS

WEATHER CONDITIONS



Wet weather results in significantly higher counts of Enterococci

CURRENT WET WEATHER STANDARDS:

>0.1″ in 24 hrs, >0.25″ in 48 hrs, >2″ in 96 hrs

PROJECT GOALS

- Develop a robust and informative storm event dataset for Parsons Creek
- Collect DNA samples at six sites to determine potential fecal contamination sources
- Collect nitrate samples to determine potential transport of septic waste
- Collect relative depth information at a representative site (BCH26) to better understand tidal flow in the Creek

GOAL

DEVELOP ROBUST STORM EVENT DATASET

IDENTIFY FECAL CONTAMINATION SOURCES

DETERMINE TRANSPORT OF SEPTIC WASTE

CHARACTERIZE TIDAL FLUX

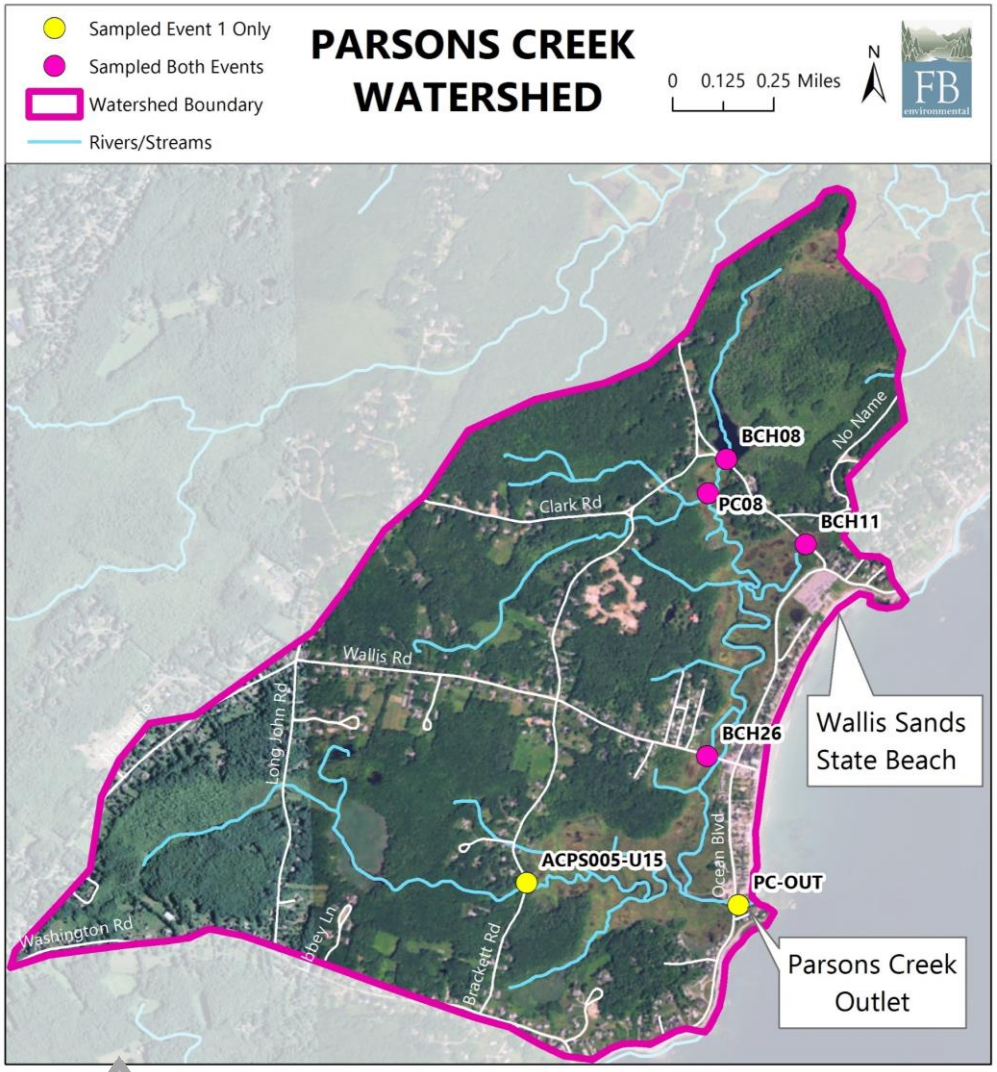
METHOD

Two Storm Events: One Small Event and One Large Event (King Tide)

Mitochondrial DNA Analysis

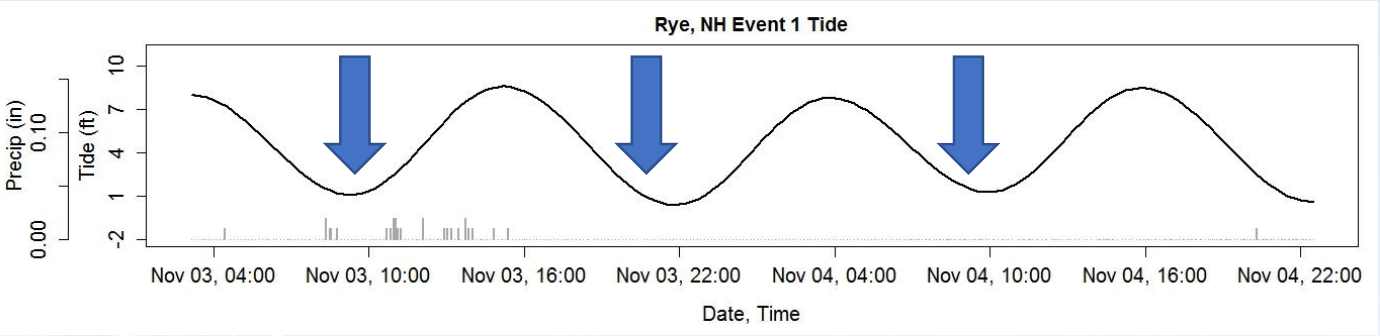
Analysis for Enterococci *and* Nitrate

Record Relative Depth & Sample at Low Tide

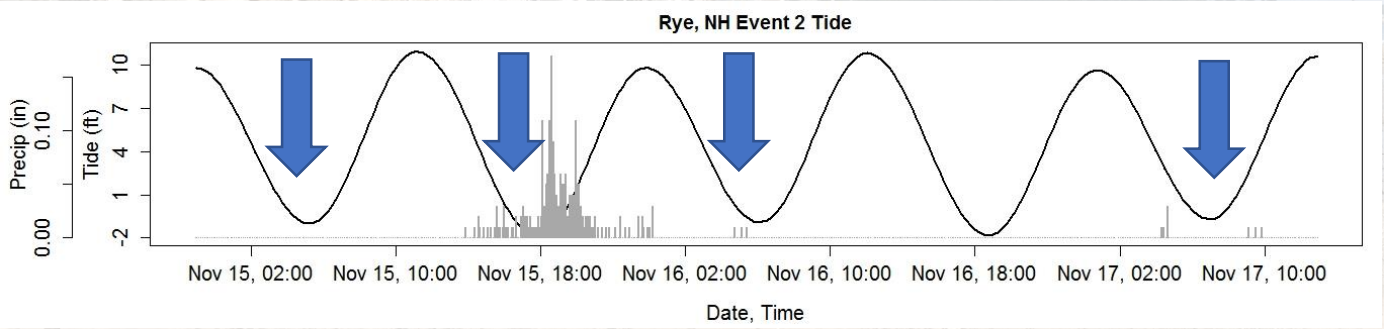

Sampled Event 1 Only
Sampled Both Events
Watershed Boundary
Rivers/Streams
PARSONS CREEK WATERSHED
0 0.125 0.25 Miles
N
FB environmental
BCH08
PC08
BCH11
BCH26
ACPS005-U15
PC-OUT
No Name
Clark Rd
Wallis Rd
Long John Rd
Washington Rd
Abbey Ln
Brackett Rd
Ocean Blvd
Wallis Sands State Beach
Parsons Creek Outlet

STUDY DESIGN

= sampling



Event #1
11/3/16 – 11/4/16
0.27 in of precipitation

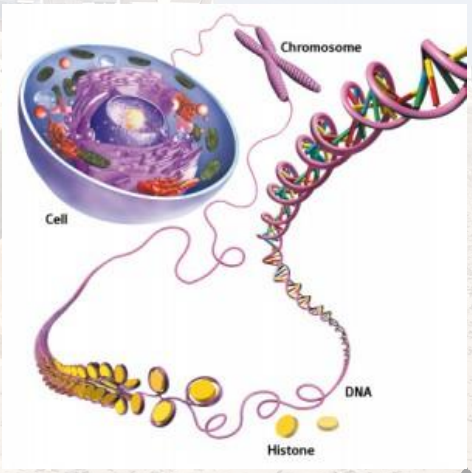


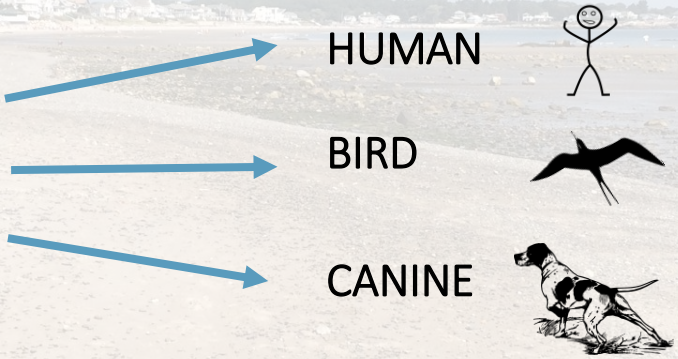
Event #2
11/15/16-11/17/16
2.23 in of precipitation

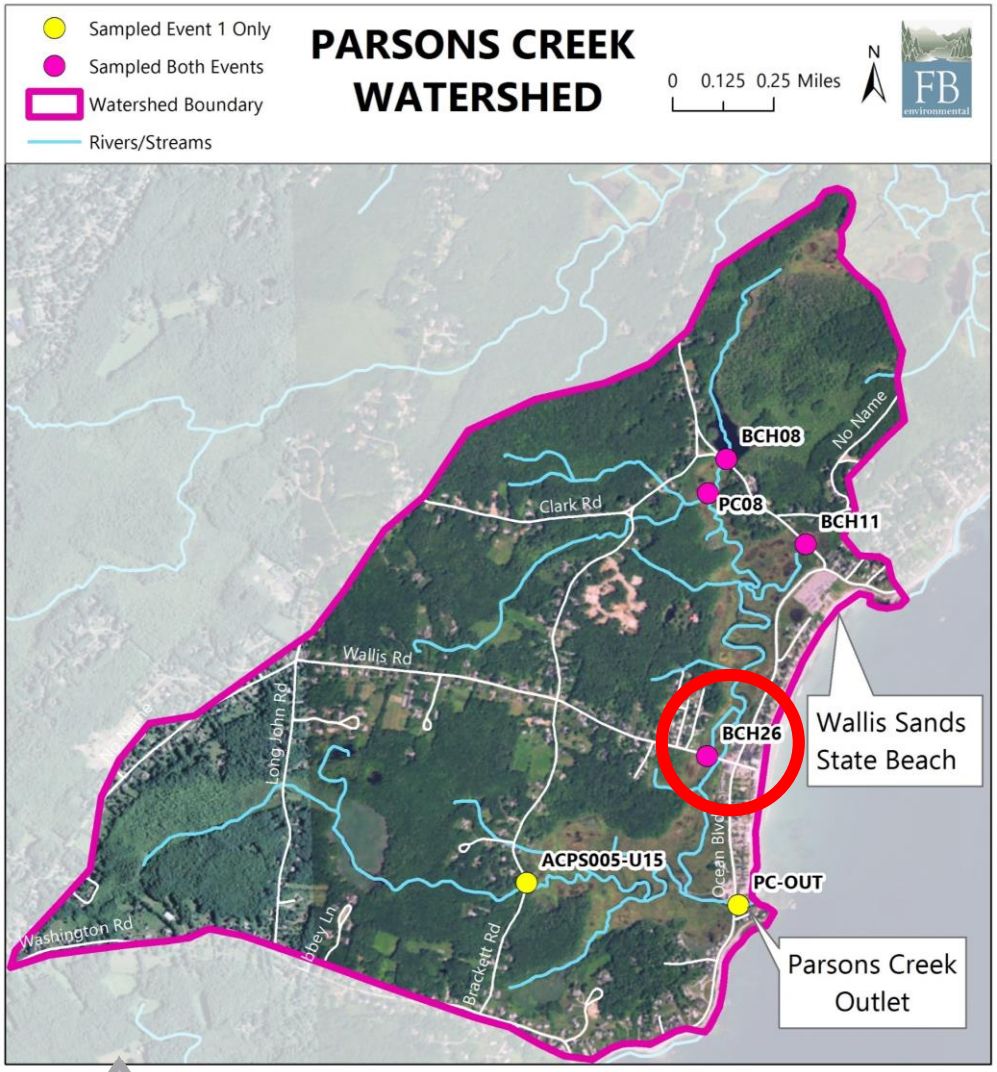
PARAMETERS

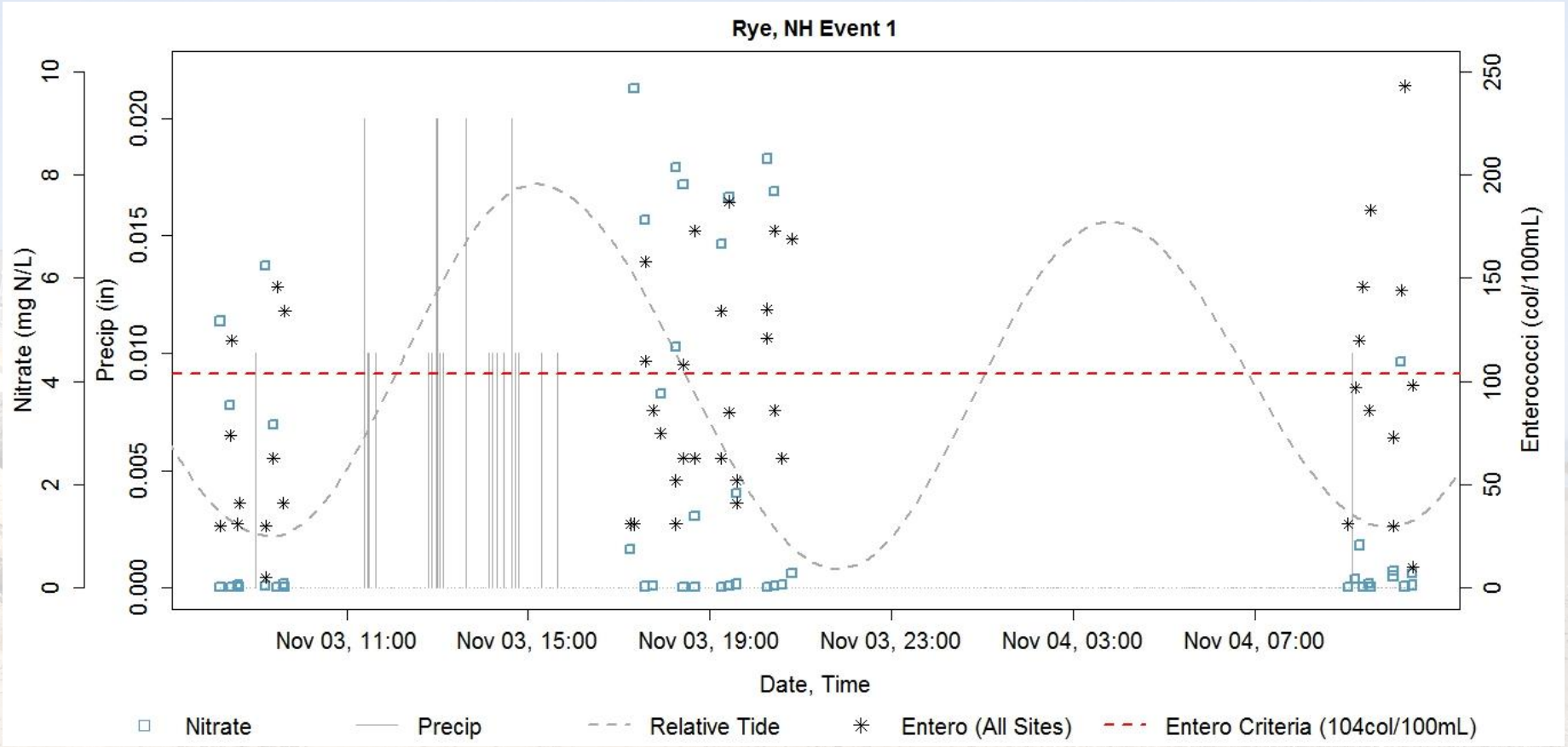
LABORATORY
- Enterococci
- Nitrate
- Mitochondrial DNA

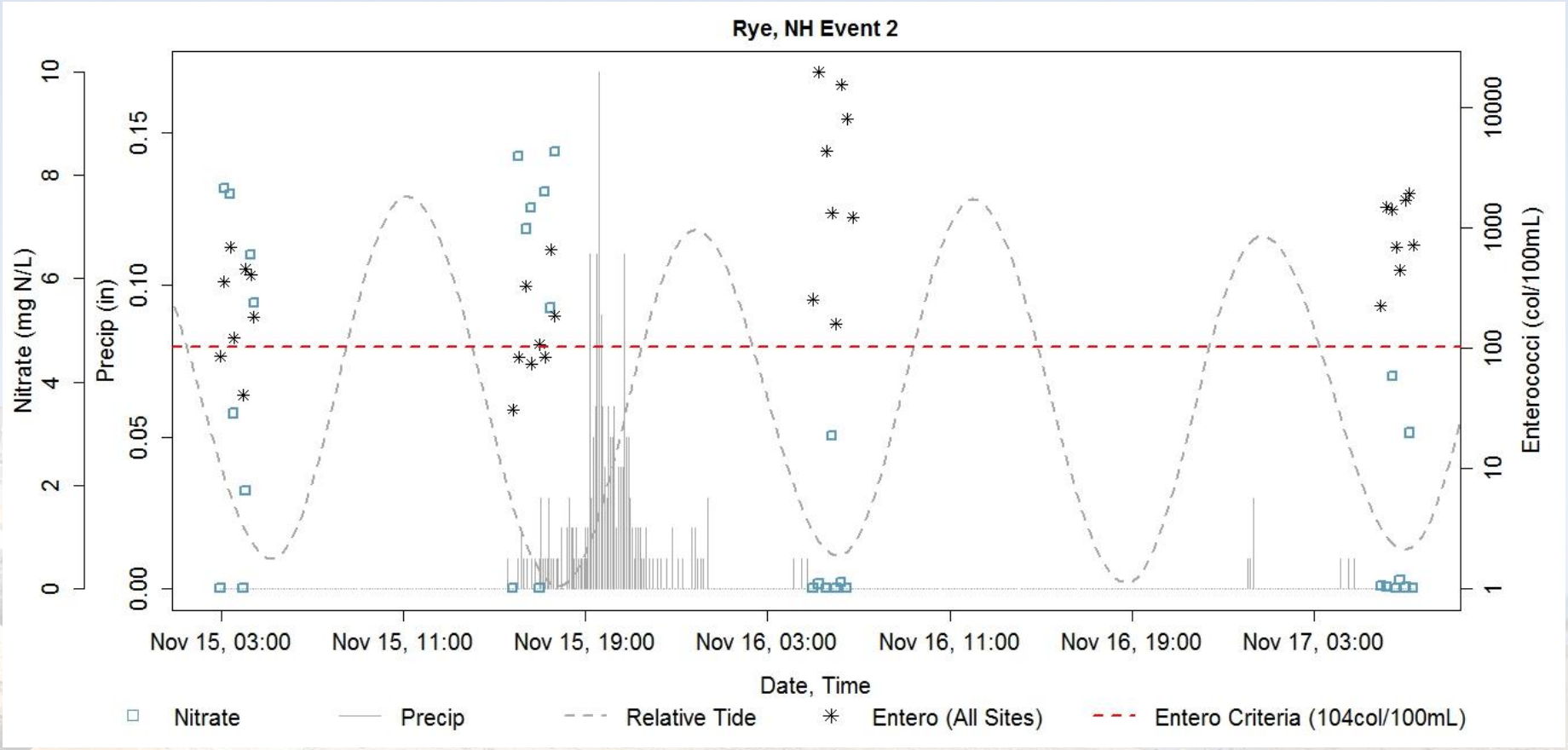
FIELD – Continuous and Discrete
- Dissolved Oxygen
- Temperature
- Salinity
- Specific Conductivity (Event #1 only)
- Relative Depth (Event #1 only)





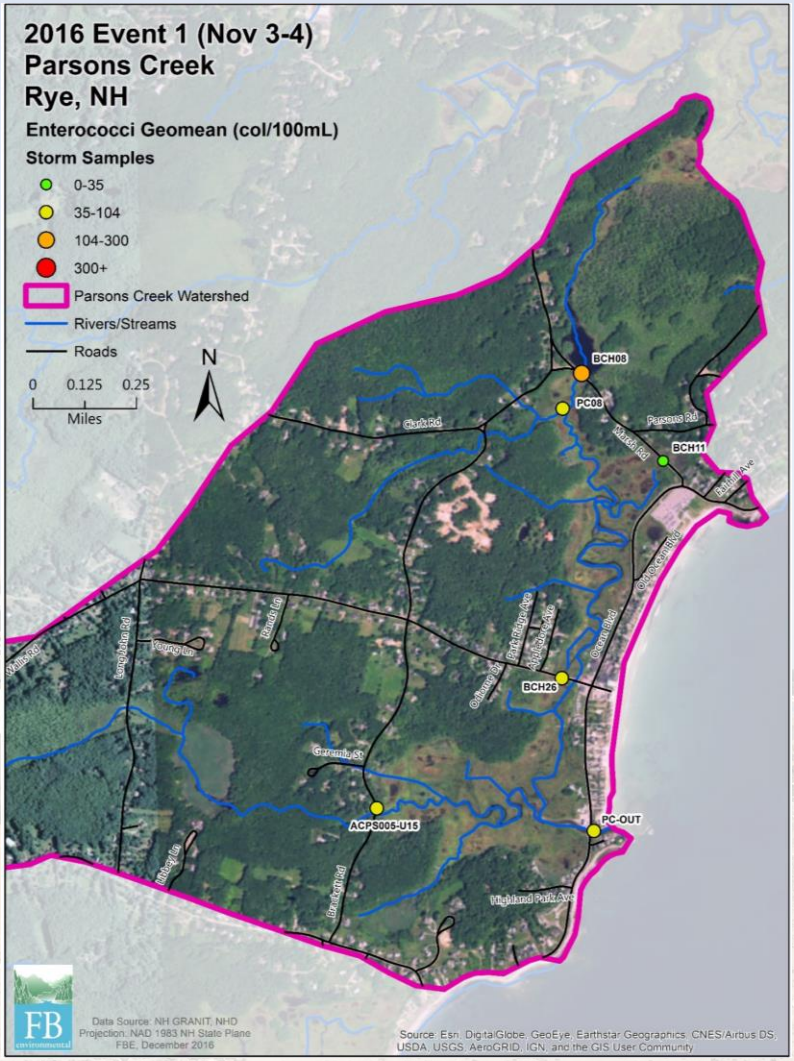

Sampled Event 1 Only
Sampled Both Events
Watershed Boundary
Rivers/Streams
PARSONS CREEK WATERSHED
0 0.125 0.25 Miles
N
FB environmental
BCH08
No Name
PC08
Clark Rd
BCH11
Wallis Rd
Long John Rd
BCH26
Wallis Sands State Beach
ACPS005-U15
Ocean Blvd
PC-OUT
Washington Rd
Abbey Ln
Brackett Rd
Parsons Creek Outlet

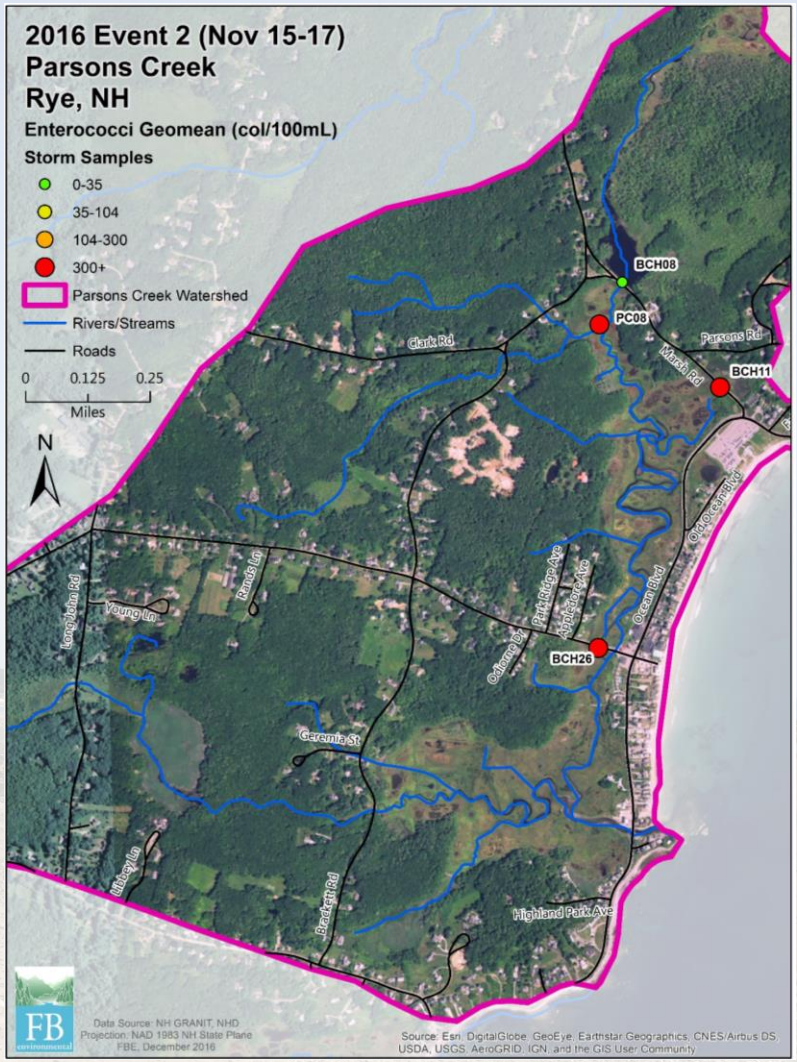

Rye, NH Event 1
Nitrate (mg N/L)
Precip (in)
Enterococci (col/100mL)
0
2
4
6
8
10
0.000
0.005
0.010
0.015
0.020
0
50
100
150
200
250
Nov 03, 11:00
Nov 03, 15:00
Nov 03, 19:00
Nov 03, 23:00
Nov 04, 03:00
Nov 04, 07:00
Date, Time
Nitrate
Precip
Relative Tide
Entero (All Sites)
Entero Criteria (104col/100mL)



Moderate to high flow events mobilize more sources of fecal waste to Parsons Creek.

Note scale differences for precipitation and *Enterococci*


2016 Event 1 (Nov 3-4)
Parsons Creek
Rye, NH
Enterococci Geomean (col/100mL)
Storm Samples
0-35
35-104
104-300
300+
Parsons Creek Watershed
Rivers/Streams
Roads
0 0.125 0.25
Miles
N
BCH08
PC08
BCH11
BCH26
ACPS005-U15
PC-OUT
Clark Rd
Parsons Rd
Marsh Rd
Ocean Blvd
Ceremia St
Highland Park Ave
Data Source: NH GRANIT, NHD
Projection: NAD 1983 NH State Plane
FBE, December 2016
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


2016 Event 2 (Nov 15-17)
Parsons Creek
Rye, NH
Enterococci Geomean (col/100mL)
Storm Samples
0-35
35-104
104-300
300+
Parsons Creek Watershed
Rivers/Streams
Roads
0 0.125 0.25
Miles
N
BCH08
PC08
BCH11
BCH26
Clark Rd
Parsons Rd
Marsh Rd
Ocean Blvd
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Data Source: NH GRANIT, NHD
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FBE, December 2016
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

TABLE 3. Nitrate (mg-N/L) results from Event 1 (November 3-4).

2016 EVENT 1 - NITRATE										
Sample ID	Pre-Storm		Storm				Post-Storm		Branch	Flow Direction
	3-Nov		3-Nov				4-Nov			
ACPS005-U15	0.06	0.08	0.03	0.02	0.08	0.06	0.08	0.05	West	Upstream
BCH08	0.02	0.02	0.03	0.02	0.05	0.04	0.03	0.03	East	|
PC08	0.02	0.02	**3.76**	**1.39**	**1.84**	0.28	0.02	0.29	East	|
BCH11	0.02	0.04	0.75	**4.67**	0.02	0.02	0.01	0.23	East	|
BCH26	**3.54**	**3.16**	**7.13**	**7.82**	**7.57**	**7.67**	0.83	**4.37**	East	|
PC-OUT	**5.17**	**6.24**	**9.68**	**8.14**	**6.67**	**8.31**	0.18	0.33	Outlet	Downstream

Bolded values are greater than 1 mg/L of nitrate-N.

TABLE 4. Nitrate (mg-N/L) results from Event 2 (November 15-17).

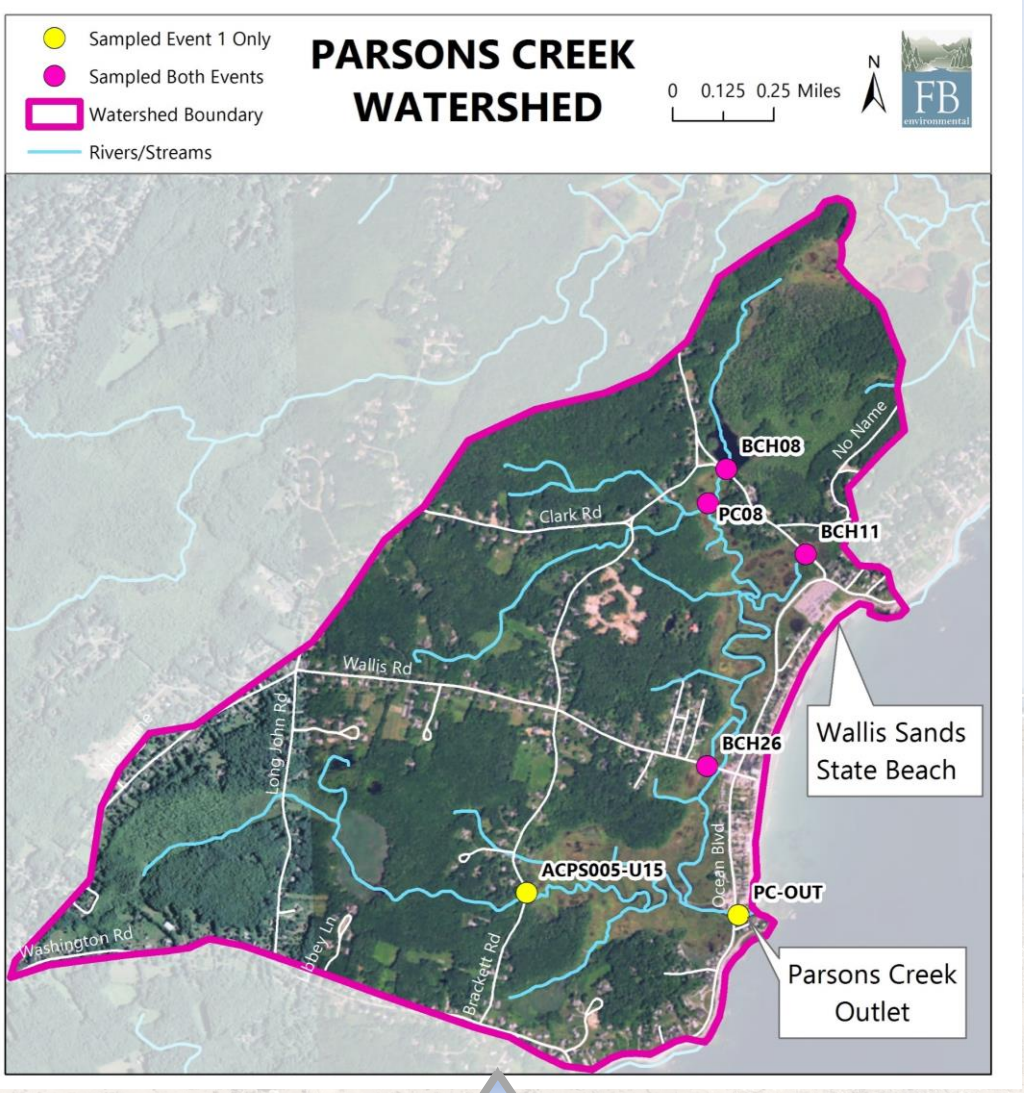
2016 EVENT 2 - NITRATE										
Sample ID	Pre-Storm				Storm		Post-Storm		Branch	Flow Direction
	15-Nov				16-Nov		17-Nov			
BCH08	0.02	0.02	0.02	0.02	0.03	0.02	0.07	0.17	East	Upstream
PC08	**7.75**	**1.91**	**8.36**	**7.67**	0.10	0.13	0.04	0.03	East	|
BCH11	**7.64**	**6.47**	**6.96**	**5.44**	0.01	0.01	**4.11**	**3.02**	East	|
BCH26	**3.40**	**5.54**	**7.37**	**8.45**	**2.97**		0.02	0.01	East	Downstream

Bolded values are greater than 1 mg/L of nitrate-N.

mtDNA

Human mtDNA detected at PC08 and BCH26. High FIB at PC08 and BCH11 potentially coming from malfunctioning septic systems of upstream residences.

Other sites (BCH08 and ACP5005-U15) have fecal contamination likely originating from wildlife.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PC-OUT
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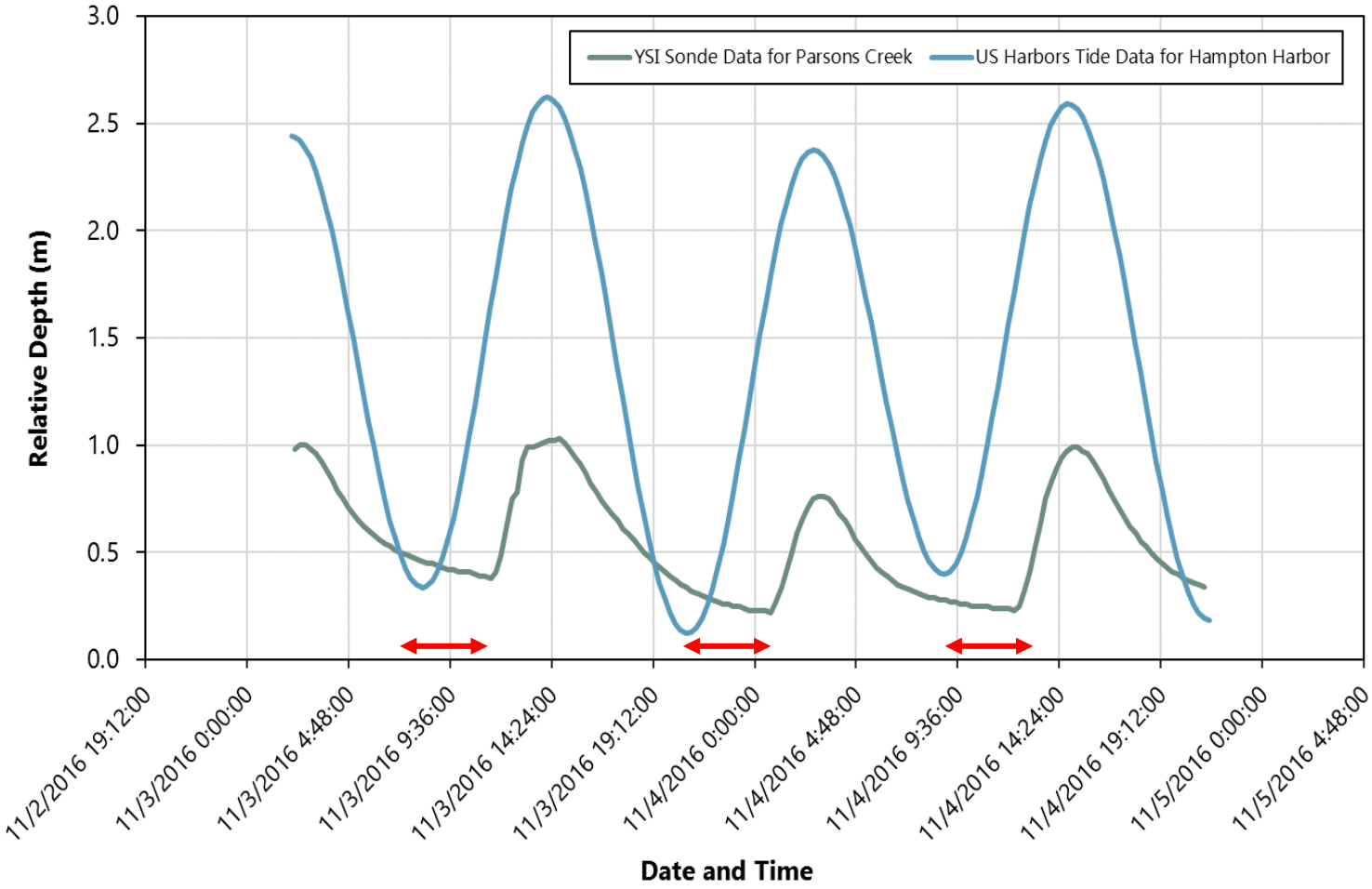

1-2 hour delay in low tide.

What do we see? Parsons Creek likely experiences a delay of 1-2 hours in low tide.

KEY CONCLUSIONS

- More fecal waste mobilized during moderate/high flow events.
- Sources originate from both human and wildlife sources.
- Parsons Creek experiences a delayed release of water during the incoming and outgoing flow around low tide. This is likely from tidal restrictions (e.g., undersized culverts) and the large water holding capacity of the marsh complex.

RECOMMENDATIONS (site specific)

- Adjust wet weather thresholds to at least 0.25″ within 24 hours.
  - Use historical data to determine site-specific thresholds during wet weather
- Adjust low tide sampling by 1-2 hours after dead low tide in Hampton Harbor
- Post advisories at beach with warning and rainfall thresholds
- Repeat sampling at variable precipitation thresholds

LIMITATIONS & NEXT STEPS

ADD CO-INDICATORS to bacteria source tracking, such as optical brighteners, ammonium, and phosphate, to aid in isolating sources of fecal contamination.

BE CAUTIOUS of interpretations due to the confounding influence of the tide. Determine cost-effective methodology to estimate flux or load of nitrate and bacteria during a storm event in a tidally influenced waterbody.

INVESTIGATE septic systems in the area, particularly above sites PC08 and BCH11, to identify if malfunctioning/low-lying systems are contributing to elevated fecal contamination.

THANK YOU
Questions?

Lauren Bizzari

Margaret Burns

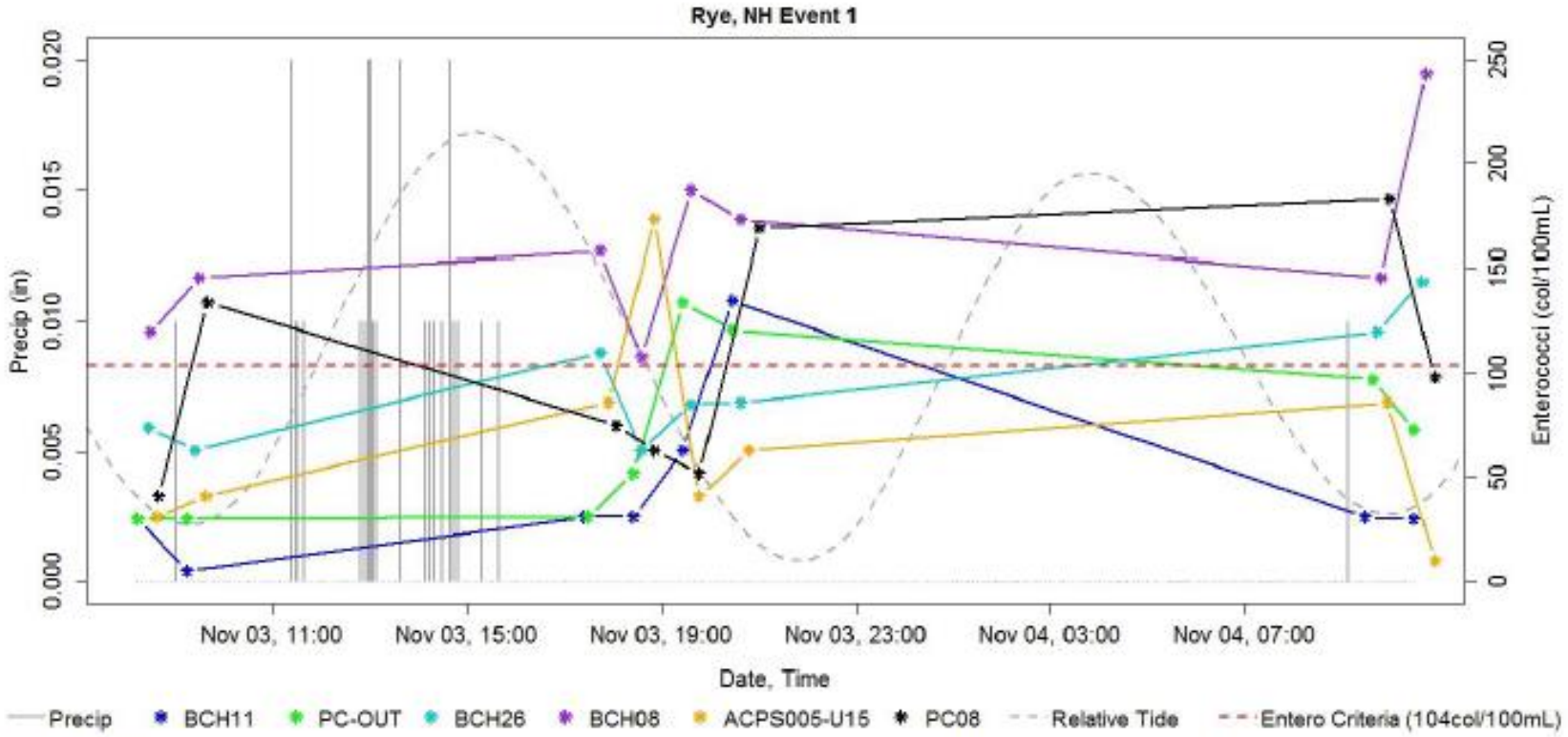

FIGURE A1. Enterococci time series by site for Event 1. Precipitation and relative tide stage are shown in gray.

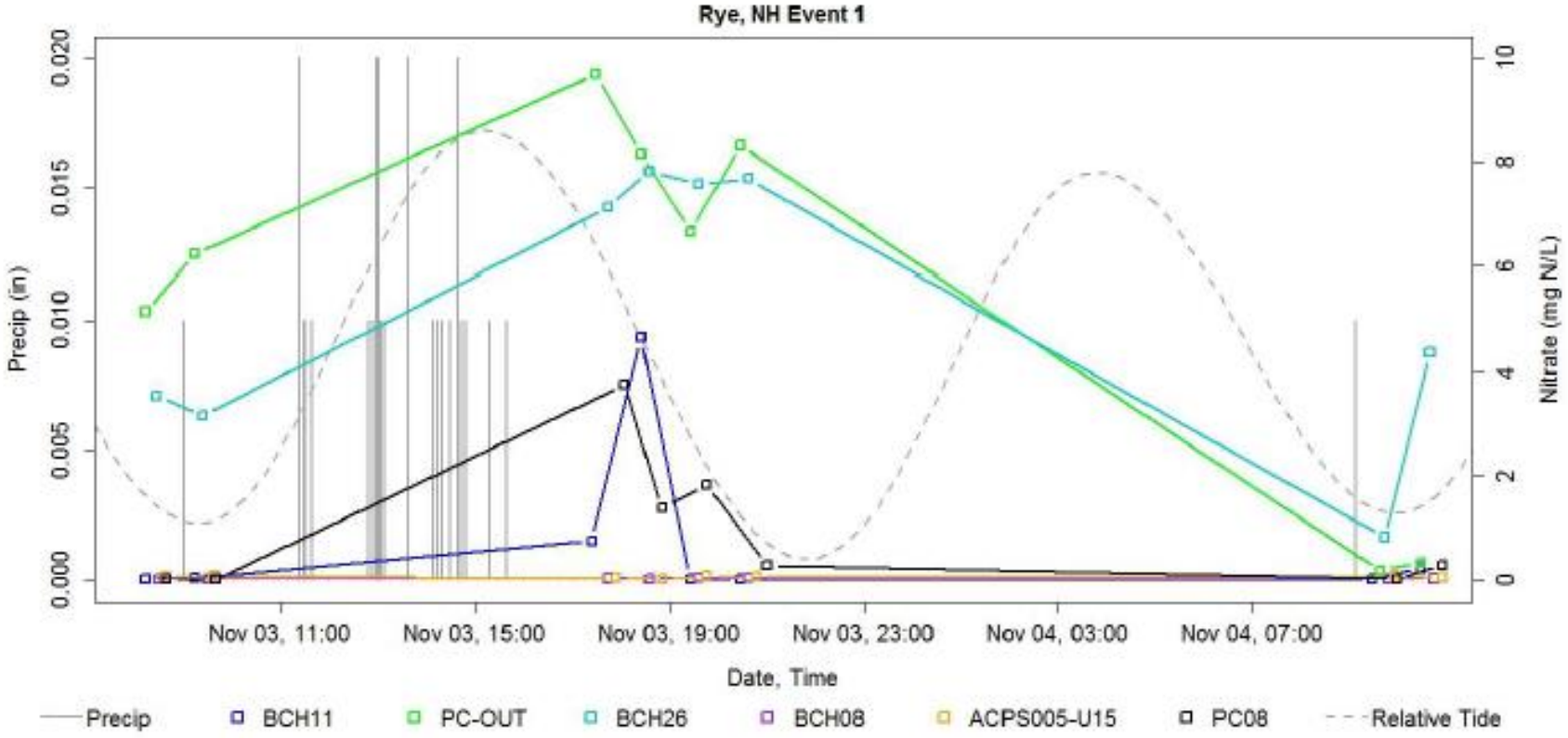

FIGURE A2. Nitrate time series by site for Event 1. Precipitation and relative tide stage are shown in gray.

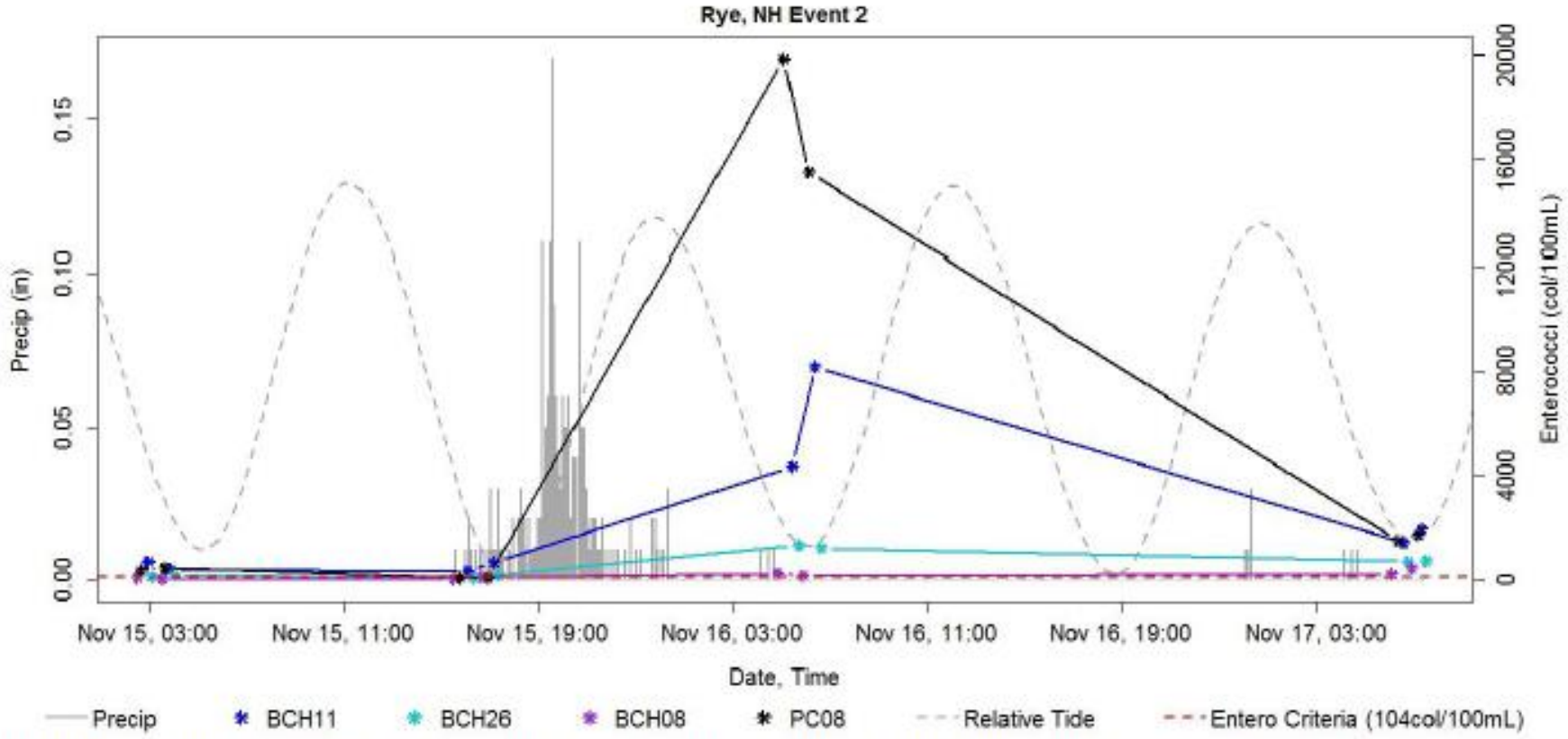

FIGURE A3. Enterococci time series by site for Event 2. Precipitation and relative tide stage are shown in gray.

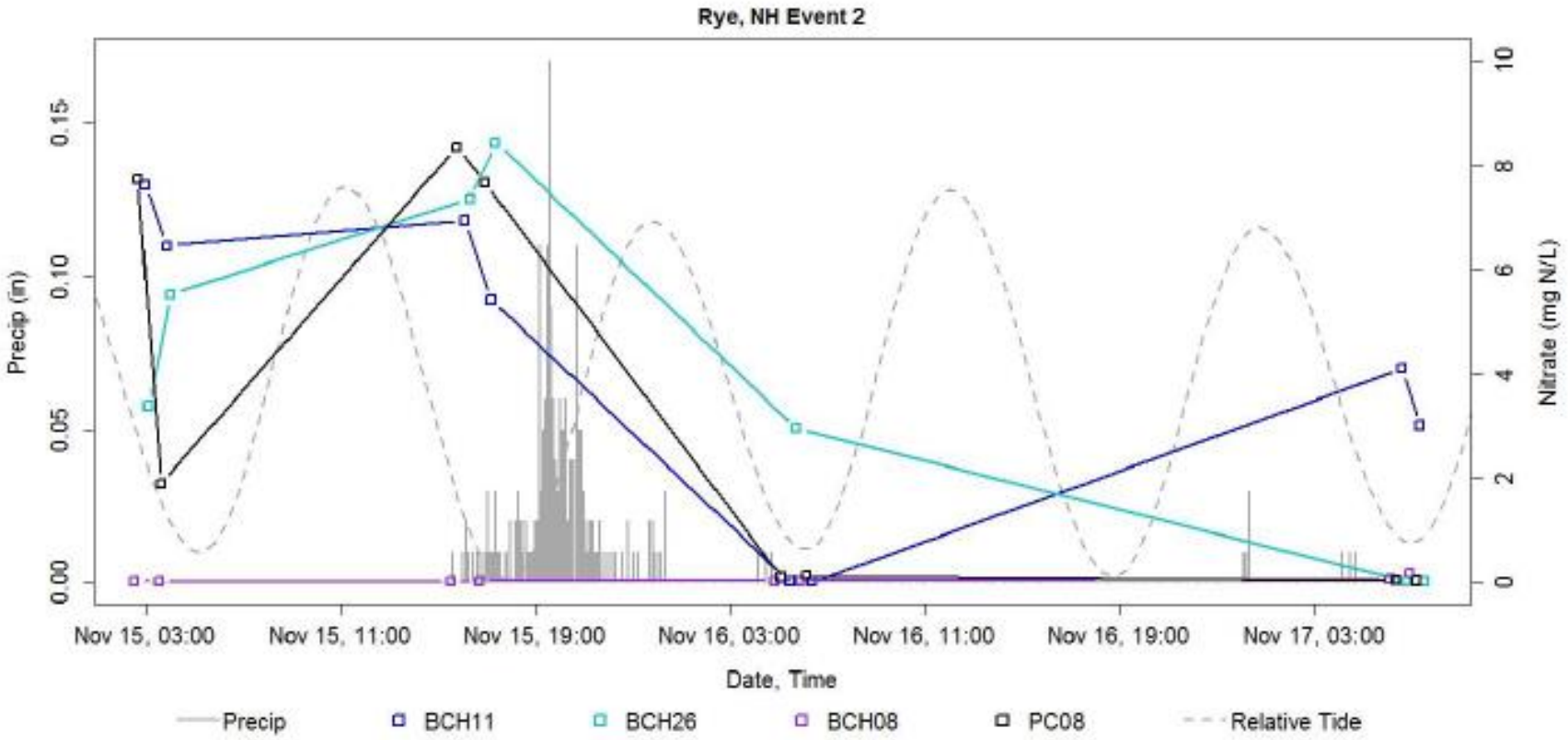

FIGURE A4. Nitrate time series by site for Event 2. Precipitation and relative tide stage are shown in gray.