

2013 WATER QUALITY DATA

MAIN STEM SPRUCE CREEK

Middle Estuary



Prepared for:

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TABLE OF CONTENTS

1. Introduction	1
2. Spruce Creek Sonde Data and Grab Sample Results	3
2.1 In-field maintenance and Grab Samples	3
2.2 Sonde Data	6
3. Next Steps.....	9
4. References	9

Acknowledgments:

*A special **Thanks** to those who made the deployment, maintenance, and retrieval of the Spruce Creek sonde possible:*

Dan and Phyllis Ford
Victor Messier
Ann Grinnell

1. INTRODUCTION

The Spruce Creek watershed is a 9.6 square mile coastal southern Maine watershed located predominately in the Town of Kittery and with a small portion of its headwaters located in the Town of Eliot, Maine. The watershed empties into the Piscataqua River 1.5 miles north of where the Piscataqua River meets the Gulf of Maine. Spruce Creek is primarily fed by six freshwater streams: Wilson Brook, Fuller Brook, Hill Brook, Hutchins Creek, Chickering Creek, and Crocketts Brook. The Creek contains approximately three square miles of tidal area that consists of high salt marsh, ledge, and mud flats.



Photo of Spruce Creek taken from the 2013 Sonde Location

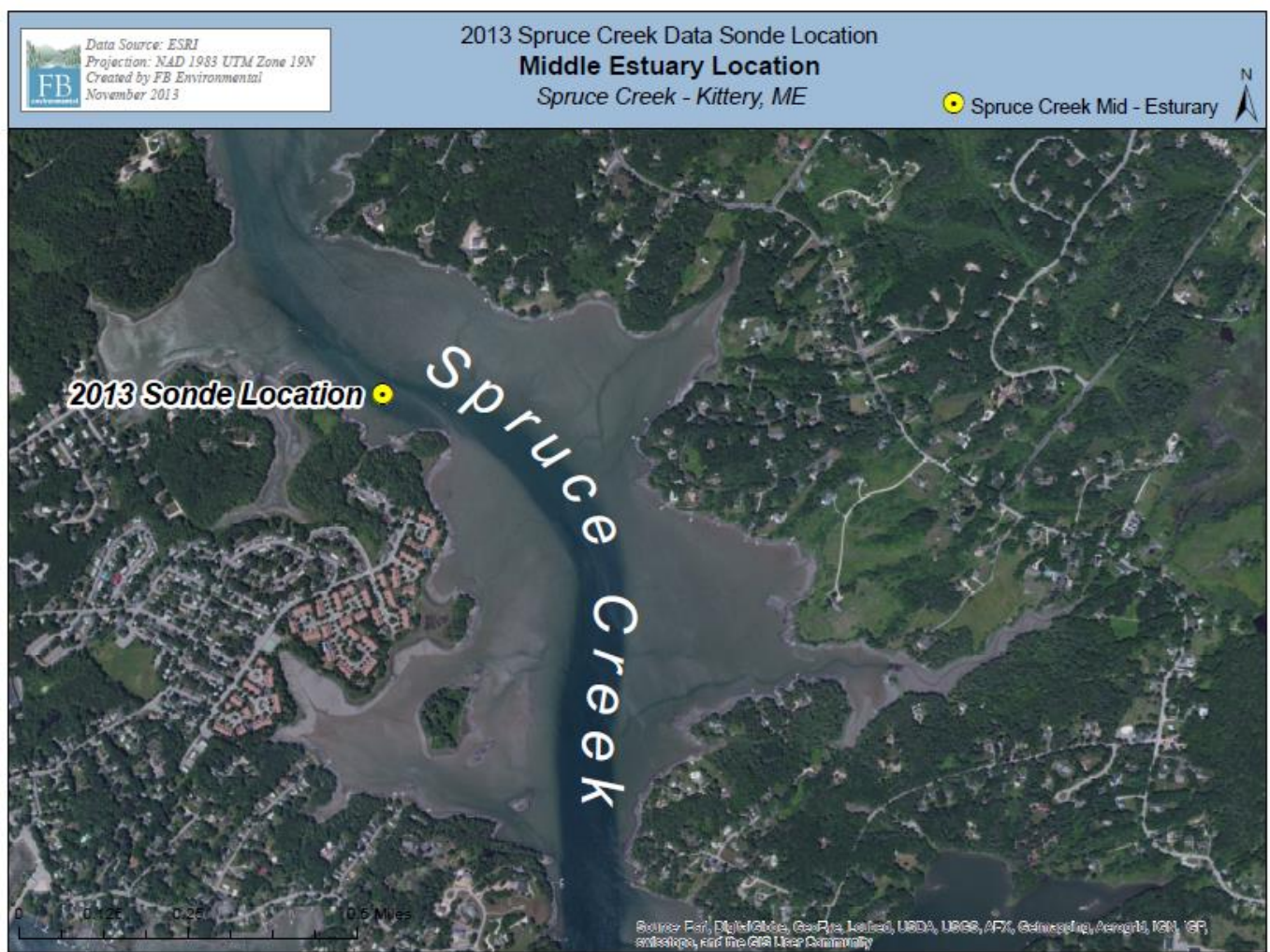
Under the Federal Clean Water Act, all water bodies have a classification based on standards established at the state level. The freshwater portion of Spruce Creek is classified as Class B and the estuary portion is classified as Class SB by the State of Maine. Class B is the 3rd highest classification for freshwater streams. Class SB marine waters are required to meet water quality standards to support the designated uses of recreation such as swimming and boating, fishing, and the harvesting of shellfish.

Due to continued poor water quality, the estuarine portion of Spruce Creek is listed in Maine's 2010 Integrated Report as impaired under Category 4-A: Estuarine & Marine Water Impaired by Bacteria (TMDL completed) for nonpoint pollutant sources. This fragile body of water is also identified by the Maine Department of Environmental Protection (Maine DEP) as a "nonpoint source pollution priority watershed" due to bacterial contamination, low dissolved oxygen, toxic contamination, and a compromised ability to support commercial marine fisheries. Finally, the Spruce Creek watershed is listed by the Maine DEP as one of seven coastal watersheds in the state being "most at risk from development."

As indicated above, Spruce Creek is considered impaired by the State of Maine due to bacteria and dissolved oxygen concentrations. Very little recent data on Spruce Creek are available, although support from the Spruce Creek Association did allow some initial data collection by FB Environmental in late summer and early fall of 2012. Given the strong water quality restoration

efforts in the Spruce Creek watershed by the Town of Kittery, it was recommended that a more complete analysis of the main channel of the Creek be conducted. To address this concern, FB Environmental (FBE) conducted some baseline water quality sampling of the marine portion of Spruce Creek. The sampling included the collection of continuous dissolved oxygen, depth and conductivity data (with the use of a sonde) at one location in the channel. In addition, surface water grab samples were collected for analysis of bacteria, nutrients, organic carbon, and total suspended solids. All data were collected from September to October 2013. It is important to note that the grab samples are a very limited “snapshot” of the water quality of Spruce Creek. Developing a more comprehensive sampling program in the Creek for multiple parameters is recommended to determine the variation in water quality parameter in Spruce Creek varies over time.

Figure 1: 2013 Spruce Creek Data Sonde Location September 12 – October 21, 2013



2. SPRUCE CREEK SONDE DATA AND GRAB SAMPLE RESULTS

Data sondes are water quality monitoring devices that stay in the water for a period of days or weeks, and record data to an internal memory. One data sonde was deployed in Spruce Creek at station *SC-Middle* (Figure 1). This site is located within the Spruce Creek estuary. The sonde was deployed from September 12 – October 21, 2013 and was anchored in the mid-estuary location as displayed in Figure 1. The sonde monitored dissolved oxygen, temperature, depth and conductivity at 15 minute intervals for 43 days. Two sets of grab samples were collected during sonde deployment and sent to Nelson Analytical for various analyses as discussed in Section 2.1.

2.1 IN-FIELD MAINTENANCE AND GRAB SAMPLES

On September 30, surface water grab samples were collected at the sonde location in Spruce Creek under low tide conditions. The sonde was briefly pulled out of the water and repositioned at the middle estuary location. A buoy system was used to allow the sonde to remain suspended just above the bottom of Spruce Creek under both high and low tide conditions. During the September 30 maintenance event, a significant amount of algae was removed from the sonde casing, rope, and anchor prior to re-deployment. Though a significant amount of algae was attached to the sonde casing, the sonde probe and wiper mechanism did not show any evidence of algal build-up and was observed to be functioning properly. On October 25th, grab samples were also collected at the sonde location. The sonde was then removed from the creek and data were downloaded.

Surface water grab sample results are shown in Table 1, below. Samples collected on September 30 and October 25 at the sonde location were brought to Nelson Analytical Water Testing Laboratory in Kennebunk, Maine and tested for the following analyses:

- Ammonia Nitrogen (NH₃)
- Biological Oxygen Demand (BOD)
- Chloride
- *E. coli*
- Nitrite Nitrogen (NO₂)
- Total Kjeldal Nitrogen (TKN)
- Total Organic Carbon (TOC)
- Total Suspended Solids (TSS)

Table 1: 2013 Spruce Creek Main Stem Water Quality Sample Results

Grab Sample Results Spruce Creek Middle Estuary Location		
Parameter	Result	
	September 30, 2013	October 21, 2013
Ammonia Nitrogen (NH ₃) (mg/L)	<0.05	<0.05
Biological Oxygen Demand (BOD) (mg/L)	<6	<6
Chloride (mg/L)	18000	22000
<i>E. coli</i> (colonies/100mL)	9	13
Nitrate Nitrogen (NO ₃) (mg/L)	< 20	<20
Nitrite Nitrogen (NO ₂) (mg/L)	<0.01	<0.01
Total Kjeldal Nitrogen (TKN) (mg/L)	<0.20	0.21
Total Organic Carbon (TOC) (mg/L)	3.1	2.6
Total Suspended Solids (TSS) (mg/L)	93	54

Ammonia Nitrogen (NH₃) is a form of inorganic nitrogen that promotes aquatic plant growth and is toxic to fish in excessive amounts. Excess ammonia can also promote algal blooms, particularly in marine waters. Ammonia nitrogen results from both sample dates are below the detectable limit for laboratory analysis at less than 0.5 mg/l. The State of Maine does not have specified criteria for ammonia nitrogen.

Biological Oxygen Demand (BOD) is used as an indication of the amount of organic pollutants in water. BOD is the amount of dissolved oxygen needed by aerobic organisms to break down organic material. Maine does not set a water quality standard for BOD in surface waters. BOD results for both sample dates were below the detectable limit for laboratory analysis at less than 6 mg/l. Unpolluted surface waters typically have a BOD concentration of 2 mg/l or less (Wenner *et al.*).

Chloride is a large constituent of dissolved solids in water. It can also give us a basis for the amount of salt ions that are flowing into a body of water through stormwater runoff from roadways and parking areas within a watershed. Chloride levels were very high during both sample dates despite low tide conditions in Spruce Creek. Chloride is high in the Spruce Creek estuary because much of the estuary contains seawater as a result of tidal cycling in the Piscataqua River. Normal offshore seawater chloride levels are approximately 19,400 mg/l. Results from both sample dates averaged 20,000 mg/l chloride concentration. Chloride levels from stormwater runoff are usually much lower as the majority of inputs to the system are from

freshwater sources. Lower chloride levels in estuary samples may indicate that more watershed-based or freshwater sources are present. Estuaries with chloride concentrations similar to that of seawater have more off-shore influence. Pollutants in these cases may come from up River or from an adjacent estuary.

E. coli is a fecal indicator bacteria. Bacteria concentrations in waterbodies can vary under different weather conditions, usually rising sharply after rainfall. Sources of bacteria include stormwater runoff, malfunctioning septic systems, pet waste, and wildlife. High concentrations of fecal indicator bacteria in waterbodies can lead to posted advisories at swimming beaches and closure of shellfish beds. These bacteria are used to signal human health risks such as gastrointestinal, respiratory, eye, ear, nose, throat, and skin infections transmissible to humans through the consumption of contaminated fish and shellfish, skin contact, and/or ingestion of water. Though Maine uses Enterococci bacteria as a standard for marine waters, *E. coli* was used in the Spruce Creek channel investigation for comparison reasons. The Town of Kittery uses *E. coli* as its bacteria parameter throughout the watershed. The Maine freshwater *E. coli* water quality standard for recreational use of Class B waters is 236 colonies/100mL for instantaneous samples, and 64 colonies/100mL for geometric means. *E. coli* concentrations during both sample dates were well below both of these levels. Fecal coliform, an alternative fecal indicator bacteria, are used to monitor for shellfish harvesting, and this parameter was not tested.

Nitrite/Nitrate Nitrogen (NO_2/NO_3) is another form of inorganic nitrogen that promotes the growth of aquatic plants and algae. It can also be toxic to fish in excessive amounts. Maine does not have a water quality standard for nitrate or nitrite in surface waters. However, natural levels of nitrate are most often below 0.1 mg/l. Waters that are affected by development and other human activity can have nitrate levels of up to 5 mg/l. Concentrations upward of this may indicate fertilizer or wastewater pollution (Wenner *et al.*). Nitrate concentrations in the Spruce Creek Estuary are inconclusive due to a laboratory detection limit of 20 mg/l. In most cases, detection limits for nitrate are much lower. However, interference from sodium and chloride at this sampling location resulted in higher detection limits. Nitrate results for both samples were less than 20 mg/l. We recommend further Nitrite/Nitrate testing using alternative laboratory methods with lower detect limits.

Total Kjeldahl Nitrogen (TKN) is the sum of ammonia and organic nitrogen. NH DES has published recommended nutrient guidelines for Great Bay (NH DES, 2009). Those recommendations indicate a limit for total nitrogen (TN) concentration of 0.45 mg/L for aquatic life. TN is the sum of TKN and nitrite/nitrate. More strict levels for TN are listed for various water column depths to protect eelgrass communities. As nitrate analysis in this study was inconclusive, further studies need to be conducted to assess the true level of TN in Spruce Creek.

Total Organic Carbon (TOC) is the amount of carbon bound in organic compounds in a sample of water. This is used as an indicator of water quality, as TOC can come from naturally decaying organic matter as well as synthetic sources like detergents, fertilizers and other chemical pollutants. Maine does not have a water quality standard for total organic carbon in surface waters. Spruce Creek TOC results from both sample dates were 3.1 and 2.6 mg/l, respectively.

Total Suspended Solids are solids present in water that will not pass through a 2-micron filter. Examples of suspended solids include sediment particles, algae, and various organic particulates. Suspended solids can carry pollutants and toxics and significantly degrade water quality in excessive amounts (US EPA, 2012). Maine has not a set water quality criteria for total suspended solids in surface waters. TSS results from the Spruce Creek grab samples are 93 and 54 mg/l, respectively.

2.2 SONDE DATA

The sonde deployed in the middle estuary location of Spruce creek collected data every 15 minutes starting at 3:00 PM on September 12 and ending at 5:15 AM on October 21, 2013. Sonde readings were removed from the data set during the sonde maintenance activity on September 30. During this time the sonde was out of the water or being maneuvered during re-deployment to the proper position in the creek. The sonde measured the following parameters:

- Temperature
- Conductivity
- Dissolved Oxygen
- Depth

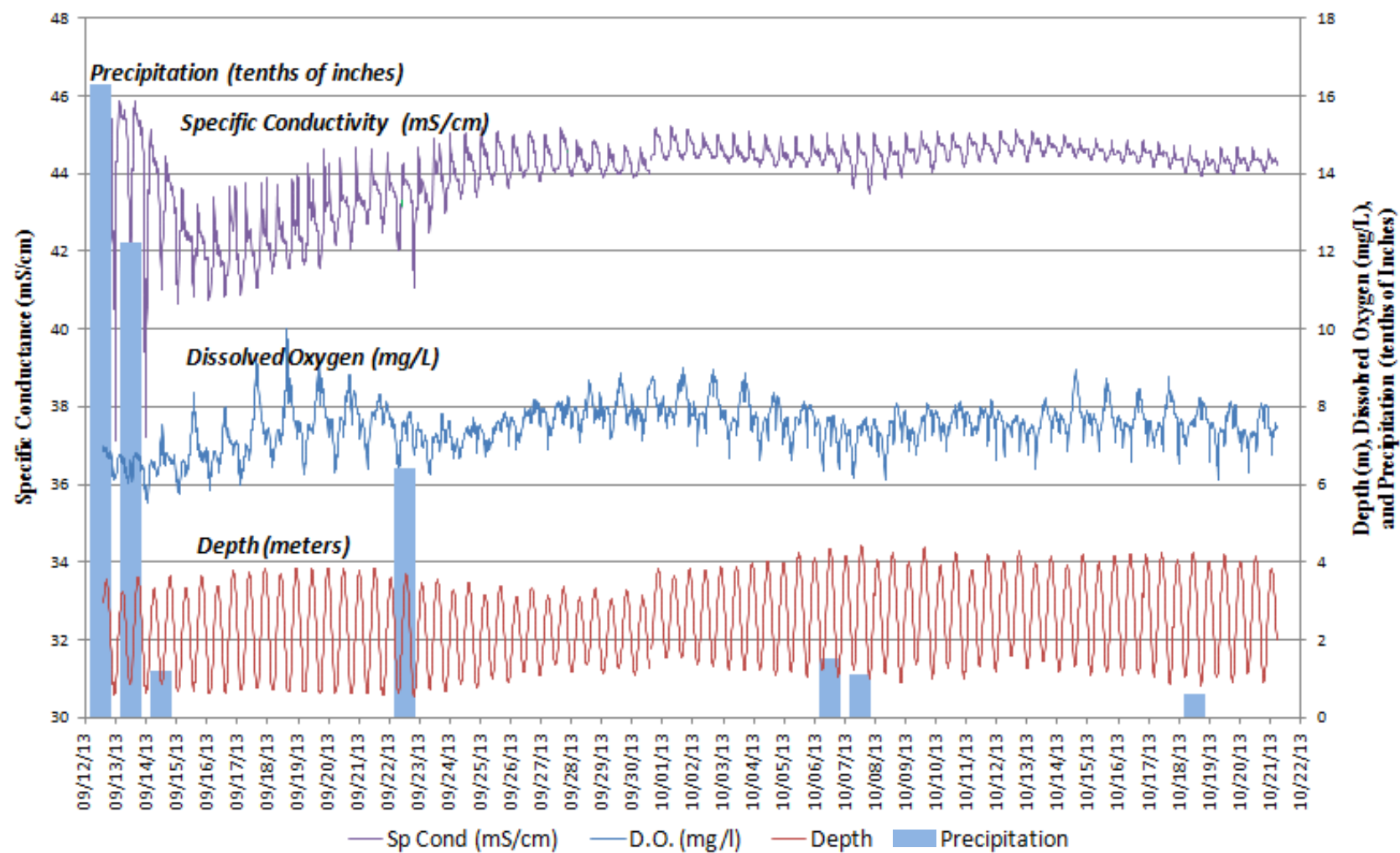
Dissolved Oxygen (DO) is the concentration of oxygen that is dissolved in the water. DO is critical to the metabolism of many aquatic organisms. The DO standard for class SB marine waters outlined in 38 MRSA §465-B, and used by the Maine Department of Environmental Protection, is a daily minimum of greater than 85% saturation. The dissolved oxygen saturation in Spruce Creek varied from 66% - 123% saturation with an overall average of 89% saturation. The minimum DO value fell below 85% on 42 of the 43 days monitored. From September 26 to October 5, 2012, the minimum DO value fell below 85% on every day of monitoring. DO values should be monitored on a regular basis in the Creek and, if possible, the use of sondes will provide the most comprehensive dataset. Low DO can result from many factors including excessive amounts of nutrients entering the Creek from freshwater sources.

Conductivity is the ability for water to pass an electric current and is determined by the amount of dissolved inorganic solids ionized in the waterbody, such as chloride and other salts. Conductivity is often used to calculate salinity (Wagner et al., 2006). Specific conductivity in

Spruce Creek varied from 37 – 46 mS/cm, with an average of 44 mS/cm. This specific conductivity range indicates salinity from about 23.5 to 30.0 practical salinity units (PSU), with full seawater salinity approximately 33 PSU. Conductivity is a good measure to help observe trends in tidal cycles.

Figure 2 presents the continuous sonde data for specific conductivity, dissolved oxygen, and depth. Daily precipitation is also included.

Figure 2: Continuous sonde data collected in Spruce Creek for specific conductivity, dissolved oxygen, and depth with daily precipitation from September 12 – October 21, 2013



3. NEXT STEPS

Continued sampling of the main stem of Spruce Creek at this location will provide valuable information and allow the Town of Kittery to track progress toward improving water quality to Spruce Creek. Creating a trend for data collected via sondes and through grab sampling will play a key role in future planning and restoration management processes within the Spruce Creek watershed. It is recommended that the Town of Kittery re-deploys a sonde at the same location in Spruce Creek in the Summer/Fall of 2014 to continue tracking water quality in the main stem of Spruce Creek.

In addition to yearly sonde deployments, a grab sampling program should be created and put into action for 2014. Weekly grab samples in Spruce Creek would provide the best data, but monthly sampling would also be valuable in this case. Reactivation and expansion of the Spruce Creek Association Volunteer Monitoring Program should be considered. Training and education of volunteers would also provide outreach opportunities within the community.

4. REFERENCES

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