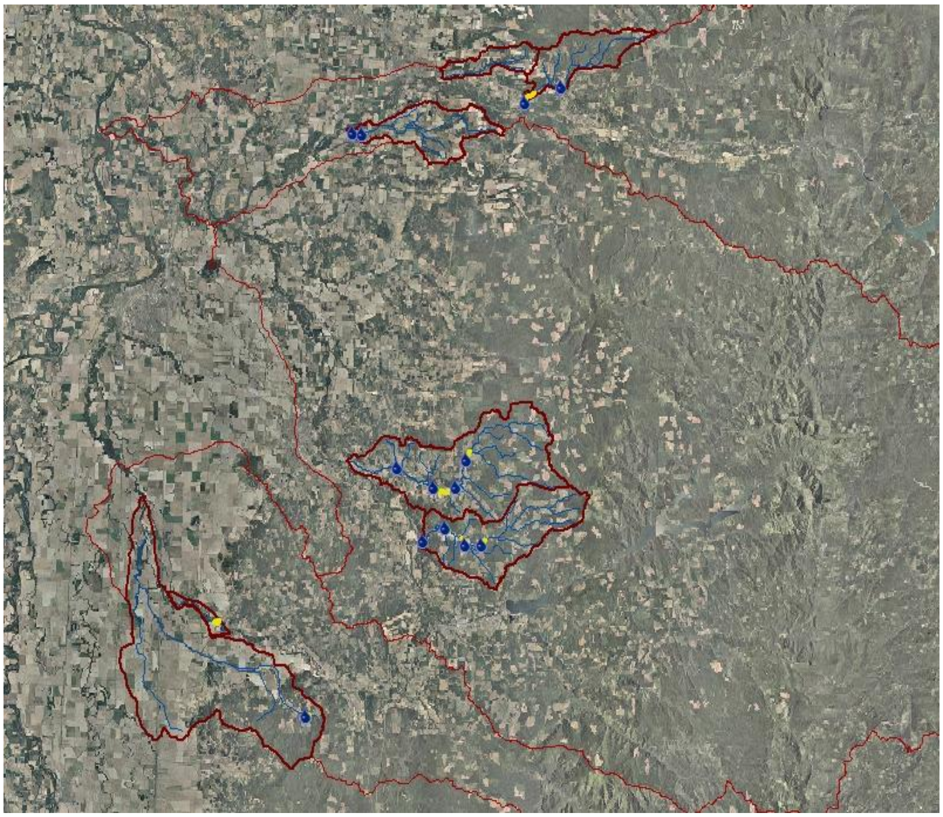
Effectiveness Monitoring Progress Report

South Santiam, North Santiam and Calapooia Watershed Councils

2010



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Summary

The North Santiam, South Santiam and the Calapooia River watersheds (NSCW) have experienced extensive anthropomorphic changes to their land base in recent decades (E&S Environmental Chemistry Inc. 2000, E&S Environmental Chemistry Inc. 2002, Primozich and Bastasch 2004). As a result of this change, the quantity and quality of in-stream and adjacent riparian habitat for ESA listed salmonids (winter run steelhead and spring run Chinook) has been degraded (NOAA 2005). In light of this situation, NSCW Councils have voluntarily formed a unique regional team, which has been accepted into the Meyer Memorial Trust (MMT) Model Watershed Program. An integral element of the MMT Model Watershed Program is a 10 year effectiveness monitoring program designed to measure the effectiveness of the NSCW restoration efforts and thus inform future management decisions. Restoration efforts are focused in seven priority subbasins. In 2010 (year 1 of the effectiveness monitoring program) 11 stream segments were surveyed to characterize instream physical habitat and adjacent riparian conditions.

Introduction

The North Santiam, South Santiam and the Calapooia River watersheds (NSCW) have experienced extensive anthropomorphic changes to their land base in recent decades (E&S Environmental Chemistry Inc. 2000, E&S Environmental Chemistry Inc. 2002, Primozich and Bastasch 2004). As a result of this change, the quantity and quality of in-stream and adjacent riparian habitat for ESA listed salmonids (winter run steelhead and spring run Chinook) has been degraded (NOAA 2005). In light of this situation, NSCW Councils have voluntarily formed a unique regional team, which has been accepted into the Meyer Memorial Trust (MMT) Model Watershed Program. Through this program, the Councils are partnering with MMT, the Bonneville Environmental Foundation (BEF), the Oregon Department of Fish and Wildlife (ODFW), the USDA Farm Service Agency, and private landowners to address limiting factors to salmonids within the study area. This fosters communication between the groups and agencies, allowing data sharing and collaboration on projects. The regional partnership between NSCW Councils is unique and cost effective, as personnel and equipment are shared amongst the three separate watershed councils. Significant savings are transferred to granting agencies as a result of the partnership.

Many NSCW streams have a limited ability to support adult and juvenile salmonids due to the interruption of processes that create and sustain salmonid habitat (Primozich and Bastasch 2004). Numerous waterways within the NSCW exceed stream temperature requirements and are listed by the Oregon Department of Environmental Quality (OR DEQ) as being 303d impaired. Tributary and mainstem rivers are commonly simplified, lack in-stream wood and have little or no off channel habitat for juveniles. In addition, spawning gravels needed by adults are not retained. Riparian forests have been reduced or removed, thus increasing the amount of solar radiation reaching the water's surface and eliminating a source of future wood recruitment into streams. A restoration program designed to reestablish interrupted ecosystem processes within the NSCW has been initiated. NSCW and BEF staff have identified seven priority subbasins to target restoration activity: Stout Creek, Valentine Creek, Bear Branch, Hamilton Creek, McDowell Creek, Courtney Creek and the 'Middle Reach' section of the mainstem Calapooia River (see Figures 1, 2 and 3).

An integral aspect of environmental restoration is the implementation of a monitoring strategy (Roni 2002). A problem with many effectiveness monitoring projects in the Pacific Northwest is that the temporal scale is not adequate to answer key research (e.g. monitoring) questions (Roni et al 2008). To account for an adequate time scale, an innovative 10 year monitoring program has been initiated in the NSCW. The goal is to measure and establish environmental conditions prior to restoration treatments in priority subbasins and to follow up restoration actions with 10 years of effectiveness monitoring. The purpose is to determine if the restoration actions that have been implemented are achieving stated objectives. The 10 year timeframe of the project is at a scale conducive to measuring change in the stated environmental parameters. By posing restoration actions in the form of a hypothesis we will be able to test our ability to accelerate environmental change in our study areas. The effectiveness monitoring that is occurring in the NSCW is part of a larger comprehensive effort occurring throughout the Willamette Basin.

We sampled a total of 11 stream segments for in-channel habitat conditions (see Table 1 and 2). Data collected included stream temperature, thalweg profile, substrate characterization, wetted width, canopy coverage, riparian condition, invasive species presence and macroinvertebrate sampling. The North Santiam had 2 stream segments sampled, 1 in Stout Creek and 1 in Bear Branch. The South Santiam had 7 stream segments sampled, 4 in Hamilton Creek and 3 in McDowell Creek. The Calapooia basin had 2 segments sampled, one in Courtney creek and one on the Middle Reach of the Calapooia mainstem. We sampled 13 locations for water temperature data. The North Santiam had 4 data loggers, 2 on Stout creek and 2 on Bear branch. The South Santiam had 8 data loggers placed, 4 on Hamilton Creek and 4 on McDowell Creek. The Calapooia had 1 data logger on Courtney Creek. There were 3 sites that had biological sampling (e.g. macroinvertebrates), all located on Hamilton Creek.

The majority of the data collected was pretreatment data in light of scheduled restoration activities. Pretreatment data is a necessary, but often overlooked component to many restoration implementation projects (Roni 2005). However, through the Model Watershed Program, essential funding has allowed the collection of pretreatment data in 15 multiple stream segments of the model watershed subbasins during the 2010 summer field season.

Table 1. Stream segment and parameters collected in 2010.

	Parameter						
Segment Code	**Thalweg Depth**	**Wetted Width**	**Substrate**	**Canopy**	**Riparian**	**Temperature**	**Macro-invertebrates**
CA-CC-S00	x	x	x	x	x		
CA-MC-S01	x						
NS-BB-S01		x	x	x	x	x	
NS-ST-S01	x	x	x	x	x	x	
SS-HT-S00							x
SS-HT-S01	x	x	x	x	x	x	x
SS-HT-S02	x	x	x	x	x		
SS-HT-S03	x	x	x	x	x	x	
SS-HT-S05	x	x	x	x	x		x
SS-MD-S01	x	x	x	x	x	x	
SS-MD-S03	x	x	x	x	x		

Table 2. Key to segment naming conventions. Stream segment CA-CC-S00-2010 would be interpreted as: Calapooia Watershed – Courtney Creek – Control Segment – Year 2010.

Watershed	
CA	Calapooia
NS	North Santiam
SS	South Santiam
Waterbody	
CC	Courtney Creek
MC	Middle Calapooia
VC	Valentine Creek
ST	Stout Creek
BB	Bear Branch
MD	McDowell Creek
HT	Hamilton Creek
Segment	
S00	Control
S01, S02	Treatment Reach #1, #2, etc
Year	
2010	Year 2010

Methods

Data collection methods were based on existing and widely accepted protocols. Key factors driving the decision to select parameters for monitoring included responsiveness, consistency, reliability and relevance (Cole 2010). Parameter measurement is determined based on the restoration activity that is occurring (see Table 3). The time frame dedicated to collecting parameter information is based on the parameters. Some parameters are more variable than others which necessitates a different timeframe for data collection (e.g. Temperature vs. Riparian condition).

Stream reaches were selected based on land owner permission and whether restoration activities will occur. The scale of the monitoring is the stream segment. The stream segment is determined by measuring the bankfull width of the stream and multiplying by 40 (Peck 2006). No stream segment will be measured that is smaller than 350 meters. There is no upper limit for the length of a stream segment, however the majority of stream segments will not be >1,200 meters. As the stream segment increases the ability to capture representative elements of the reach becomes diluted.

Table 3. Sampling Frequency for parameters.

Action	Parameter	Pre-project (years)	Post-project (years)
In-stream Wood/Boulders	Thalweg Profile	1	1, 5, 10 & as needed
Riparian Planting, Fencing	Water Temperature	Up to 4	Annual
Riparian Planting, Fencing	Canopy Coverage	1	5 and 10
Either activity	Riparian Condition	1	5, 10 & as needed
Either activity	Macroinvertebrates	Up to 4	Annual
Either activity	Substrate	1	5 and 10

Parameters

Water Temperature

Water temperature is a driving force within aquatic ecosystems (Allan and Castillo 2007). Water temperature was measured continuously every 15 minutes during the summer flow period using Hobo data loggers and accompanying Hoboware software (Onset Computer Corporation). Hobo data loggers will be calibrated to NIST handheld digital thermometers which have been distributed by OR DEQ. Calibration procedures will follow those outlined in Chapter 6 of the Water Quality Monitoring Guidebook (Oregon Plan for Salmon and Watersheds 1999). Hobo data loggers will be distributed within the creeks based on procedures outlined by Oregon Department of Forestry 2003 "RipStream" study. Data loggers will be anchored to streamside trees and held in place using 1/8" aircraft cable and 10 lb. weights. The average daily maximum, average daily mean, average seven day average and maximum seven day average maximum temperatures were calculated. Placement of data loggers had multiple objectives. When possible, a temperature logger was placed at the farthest downstream point and highest upstream point of a segment. In some streams several loggers were placed to measure the rate of warming of the stream. Some data loggers were placed in areas outside of treatment reaches and not all treatment reaches had a temperature logger.

Thalweg

A thalweg profile can be used as a method of assessing juvenile salmonid habitat (Mossop and Bradford 2006). Thalweg measurements of stream segments were obtained following methods outlined in EMAP protocol (Peck et al. 2006). Measurement intervals were approximately 0.5 to 0.25 wetted channel widths, ensuring the capture of a representative sample of pools and pool tail outs. One surveyor stands at point 0 and the second surveyor walks directly up the middle of the channel to the established interval distance. The thalweg, which may not be in the center of the channel, is then measured and recorded. Points to measure thalweg were distributed longitudinally along the stream segment. Sites generally had at a minimum 101 points to record thalweg. Thalweg measurements were plotted and standard deviation used as a means to measure the stream segment's complexity. Thalweg profiles are expected to become more variable (e.g. complex) with placement of log structures.

Substrate

Steam substrate is widely recognized as an integral element of salmonid habitat (Keeley and Slaney 1996). Substrate particle size can influence spawning location preference and dissolved oxygen reaching salmon eggs and alevins (Bjornn and Reiser 1991). Substrate measurements will be recorded and classified following the EMAP protocol to produce a general characterization of substrate within the reach. The percent of substrate in various size classes and embeddedness will be evaluated. Fifty one transects were established within the surveyed stream segment and scaled to the stream segment. At each transect five substrate measurements will be recorded from 0%, 25%, 50%, 75% and 100% of the stream's wetted width. The water depth and wetted width at the location of substrate sampling was also recorded. In addition, substrate was examined for invasive New Zealand mud-snails.

Canopy Coverage

The percent of canopy coverage is an indicator of the amount of solar radiation reaching the water surface of the stream. Riparian shade is an important driver influencing water temperature. Measuring canopy coverage will follow the EMAP protocol (Peck et al. 2006). At 51 transects, evenly distributed along the stream reach, 6 canopy measurements will be taken at a distance of 0.3 meters above the surface of the water using a convex spherical densiometer. One measurement each on the right and left edge of water and four measurements in the center of the channel (up, right, down and left

Bank Stability
Excessive sedimentation into streams is detrimental to water quality. The bank erosion hazard index (BEHI) can be calculated to identify areas for treatment (Rosgen 1996). The stream bank height to bankfull height, root depth to bank height, root density, bank angle and surface protection are quantified and combined, yielding a ranking of the erosion hazard. It is expected that the hazard value would decrease as restoration activities proceed.

Riparian
The condition of riparian forests is important for determining the future recruitment of wood into streams. Riparian condition was assessed utilizing EMAP protocol (Peck et al. 2006). Eleven transects were evenly distributed along the stream segment. At each transect, riparian condition was visually characterized within a 10 meter square plot extending inland from the stream's edge on the right and left stream bank. Vegetation type and percent aerial cover were recorded for three layers of vegetation: canopy >5 meters, mid-canopy $\leq$ 5 to 0.5 meters and ground cover < 0.5 meters. Invasive species were also recorded. This widely used method of assessing riparian condition yields semi-quantitative information on the quantity and type of vegetation within the stream reaches.

Macroinvertebrate Sampling
The composition of the macroinvertebrate community is a widely used biological indicator for instream conditions. Macroinvertebrate samples were collected following Level 3 protocol outlined in the Chapter 12 of the Water Quality Monitoring Guidebook (Oregon Plan for Salmon and Watersheds 1999). Macroinvertebrate kick samples were collected from one control site and two treatment sites during late summer (Aug-Sept) of 2011 and 2012. Samples were collected from the lower portion of the treatment and control reaches. Each sample was composed of a composite of four subsamples taken from four different riffle habitat units. A 1ft D net with 500 micron mesh was used to obtain each kick sample. Aquatic invertebrates were preserved in one quart Nalgene bottles with 70% ethyl alcohol and sent to a qualified laboratory for identification. In the laboratory, experts identified a 500 organism subsample (e.g. 'occurred') to genus and species. The predictive model "PREDATOR" was used to establish an 'expected' list of macroinvertebrates. The occurred macroinvertebrates (e.g. O) were compared to a list of 'expected' macroinvertebrates (e.g. E) to produce an O/E ratio (e.g. score). The O/E score will then be compared to reference site scores to generate a condition of the sampled sites. An O/E score of 0.75 or less is considered impaired. It is expected that the O/E score will move toward reference scores as restoration actions are completed.

<u>Additional Monitoring</u>
Fish Sampling
Fish sampling will incorporate passive fish traps (winter-spring) and/or daytime snorkeling (summer). Fish traps will be deployed and maintained by South Santiam Watershed Council staff. Fish Traps are placed in areas of stream flow and checked at regular intervals. Fish sampling will provide needed relative abundance and presence/absence data in locations prior to habitat improvement projects. Sampling will occur under an existing permit obtained by ODFW.

Photo Points

Photo points are a non-quantitative method of documenting change at a particular location. Photographs are an easy way to illustrate change over time at a project site (see OWEB methods). All stream segments have photographs taken of the beginning and end points of the survey. In addition, permanent photo points are established at different locations within project areas.

Results

The data collected in 2010 provided year one base line data for projects occurring throughout the priority subbasins (see Appendix A, B and C). Segment CA-MR-S01 is located on the largest river (5th field) and had the deepest thalweg profile. However, because of its size it should not be compared to the other smaller creeks (e.g. 6th field).

Water Temperature
All priority subbasins within the North Santiam watershed and Hamilton Creek are designated cold core water habitat by Oregon Department of Environmental Quality (DEQ). The remaining priority subbasins are DEQ designated salmon and trout rearing and migration use. Streams with these designations should not exceed 60.8°F and 64.4°F, respectively, for the seven day average. Of the 8 temperature loggers located in cold core water habitat, all recorded temperatures well above 60.8°F for a majority of the time the loggers were deployed. Of the 5 temperature loggers located in the salmon and trout rearing and migration use designated streams, two sites did not exceed the state recommended 60.8°F for the seven day average. The treatment segment with the highest maximum seven day average maximum temperature (76.25° F) was SS-HT-S01-2010. Treatment segment CA-CC-S00-2010 had the lowest maximum seven day average maximum temperature (62.97° F).

Thalweg
Stream segment CA-MR-S01-2010 had the deepest (mean=89cm) and most variable (stdev=52) thalweg profile. This was expected as it is the largest river in the survey and an outlier within the stream segments measured for thalweg. Segment NS-ST-S01-2010 had the second deepest (mean=60cm) profile and variable thalweg (stdev= 36) profile. Segment CA-CC-S00-2010 is a control reach and had the shallowest (mean=12cm) and the least variable (stdev=8cm) thalweg profile.

Substrate
Stream segments SS-HT-S05-2010 and SS-MD-S01-2010 had the highest percentage of substrate composed of cobble and coarse gravel (66.3%). Stream segment NS-ST-S01-2010 had the highest percentage of sand and fines (47.8%). Stream segment SS-HT-S03-2010 had the lowest percentage (12.2%) of fines and sands composing the reach. The embeddedness of substrate ranged from 21% to 57% for all reaches surveyed.

Canopy Coverage
Canopy coverage was highly variable overall, at stream banks and in mid-channel for all sites except CA-CC-S00-2010. Mean overall canopy cover was ≥51% in all stream segments. Mean canopy cover at the banks was ≥65% at all segments. Mean canopy cover at mid-channel was ≥30% at all segments.

Bank Stability
Bank stability was not measured at any stream segment in 2010.

Riparian
Stream segment NS-BB-S01-2010 had the highest percentage (mean=27%) of the riparian area in large diameter trees (dbh > 0.3m), while segment SS-HT-S02-2010 had the smallest (mean=7%). Stream segment CA-CC-S00-2010 had the highest percentage (mean=35%) of small trees (dbh<0.3m) and segment SS-HT-S01-2010 had the smallest (mean=10%). The percent of the reach with woody shrubs in the understory was highest at segment CA-CC-S00-2010 (mean=70%), while the lowest was at SS-MD-S03-2010 and NS-ST-S01-2010 (mean=23%). Herbs and grasses in the understory was highest at NS-ST-S01-2010 (mean=65%) and lowest at CA-CC-S00-2010 (mean=24%). Bare was highest at SS-MD-S03-2010 (mean=25%), although most sites were much less (mean$\leq$ 8%). All segments had three vegetation layers in the canopy (mean$\geq$59%). Invasive vegetation was found at all sites in both the understory and the ground cover.

Macroinvertebrate Sampling
None of the three locations sampled for macroinvertebrates were considered impaired. Two of the three locations had duplicate sampling. The lowest score (O/E=0.81 and 0.90) was found at segment SS-HT-S01-2010, the remaining sites were not impaired (O/E$\geq$1.00).

Fish Sampling
One site on Valentine Creek had a passive hoop trap placed during November 2010. Coho salmon, , were captured at the trap confirming presence of coho in the stream. In addition, several nongame species were captured. No other sites had fish traps during 2010.

Temperature Logger Summary

LOGGER	Watershed	SubBasin	Segment	Start Date	End Date	n	Avg Daily Mean	n	Avg Daily Max	n	Avg 7-day AvgMax	n	Max 7-day AvgMax	n
9711526	Calapooia	Courtney Creek	CA-CC-S00	7/28/2010	9/27/2010	62	56.55	62	64.76	62	58.76	56	62.97	56
9711523	N. Santiam	Stout Creek	NS-SS-S01	7/29/2010	9/23/2010	57	64.67	57	78.91	57	69.06	51	76.51	51
9711535	N. Santiam	Stout Creek	none	7/29/2010	9/23/2010	57	59.19	57	70.24	57	62.88	51	68.27	51
9711534	N. Santiam	Bear Branch	NS-BB-S01	7/29/2010	9/23/2010	57	62.47	57	74.64	57	66.12	51	72.54	51
9711524	N. Santiam	Bear Branch	NS-BB-S01	7/29/2010	9/23/2010	57	62.06	57	72.87	57	65.17	51	71.22	51
9711531	S. Santiam	Hamilton Creek	SS-HT-05	8/3/2010	9/23/2010	52	58.70	52	71.62	52	63.29	46	69.68	46
9711522	S. Santiam	Hamilton Creek	none	7/30/2010	9/23/2010	56	64.89	56	77.99	56	68.70	50	76.06	40
9711529	S. Santiam	Hamilton Creek	SS-HT-S01	7/30/2010	9/23/2010	56	63.87	56	78.17	56	68.65	50	76.25	50
9711528	S. Santiam	Hamilton Creek	SS-HT-S03	8/25/2010	9/27/2010	34	59.98	34	70.93	34	62.70	28	65.08	28
9711530	S. Santiam	McDowell Creek	none	8/4/2010	9/27/2010	55	57.05	55	66.21	55	58.85	49	64.22	49
9711527	S. Santiam	McDowell Creek	SS-MD-S03	8/4/2010	9/27/2010	55	57.95	55	67.89	55	60.08	49	65.87	49
9711525	S. Santiam	McDowell Creek	SS-MD-S01	8/5/2010	9/27/2010	54	61.87	54	76.25	54	66.36	48	74.50	48
9711532	S. Santiam	McDowell Creek	none	8/5/2010	9/27/2010	54	62.49	54	75.33	54	65.55	48	73.63	48

Discussion

General
Data collection efforts during 2010 established baseline conditions at several sites prior to restoration work was to occur. It is expected that as restoration efforts progress the conditions at treatment segments will change over time. The change in the conditions at various stream segments will be compared by graphing the mean values of the parameters at treatment and control sites. A difference in the values will indicate a change. For example, it is expected that the mean seven day stream temperature of the control site CA-CC-S00 will remain consistent in the coming years. As riparian plantings become established at downstream treatment segments, the mean seven day stream temperatures should decrease at treatment segments. It is expected that a downward trend in stream temperature at the treatment segments would be seen.

The selection of control sites has been a challenge in the monitoring program. A main driver in the challenge is the participation of landowners, as monitoring efforts can only occur where landowners grant permission. In addition, even though the establishment of control reaches is crucial to the program some landowners feel slighted in not having a project occur on their property. Communicating the importance of the control sites is essential in the monitoring program. Another important element in establishing the controls is choosing control segments that are similar to treatment sites.

Discussion of Results
Numerous factors affect summer stream temperature; however it is expected that summer stream temperature will decrease over time as riparian plantings increase canopy coverage. It may take several years to detect a change in stream temperature. As riparian plantings progress and become established, the percentage of woody vegetation should increase. In addition, it is expected that the percentage of invasive plants will decrease as treatment segments undergo site preparation.

Most study streams have experienced some form of "stream cleaning" or wood removal. In some instances splash damming or stream channel straightening has contributed to a decrease of channel complexity. Thalweg conditions should become more variable (e.g. more complex) after placement of instream structures. The addition of complexity to existing streams will promote sorting of substrate particles, diffuse stream velocities, increase river length and provide habitat for numerous aquatic organisms.

Macroinvertebrate O/E scores are expected to remain the same or increase as treatments progress. Increased shade from riparian plantings will reduce solar radiation reaching the creek surface. In addition, placement of instream log structures will help retain stream gravels and promote hyporheic water exchange. It is expected that cooling of the stream temperatures will benefit macroinvertebrates.

Data collection will continue in 2011. The addition of control sites will provide a much needed comparison for existing treatment segments. Additional stream temperature loggers will help determine the rate of warming of individual creeks.

Acknowledgements

The Watershed Councils are grateful to the many private landowners who granted access to their properties. Bonneville Environmental Foundation, in addition to several others, provided technical guidance in the development of the monitoring plan. This project was funded by the Meyer Memorial Trust.

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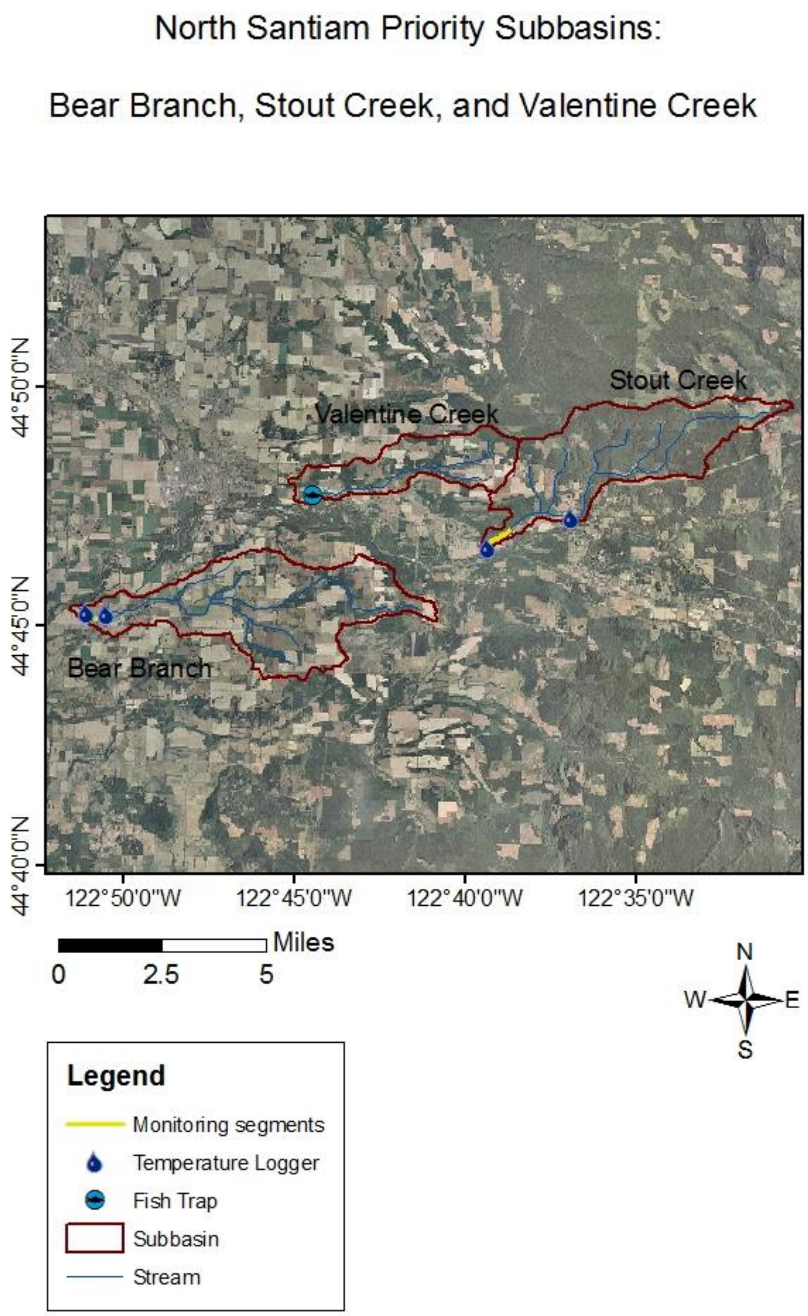


Figure 1. Map of the North Santiam Watershed Council's priority subbasins and monitoring locations.

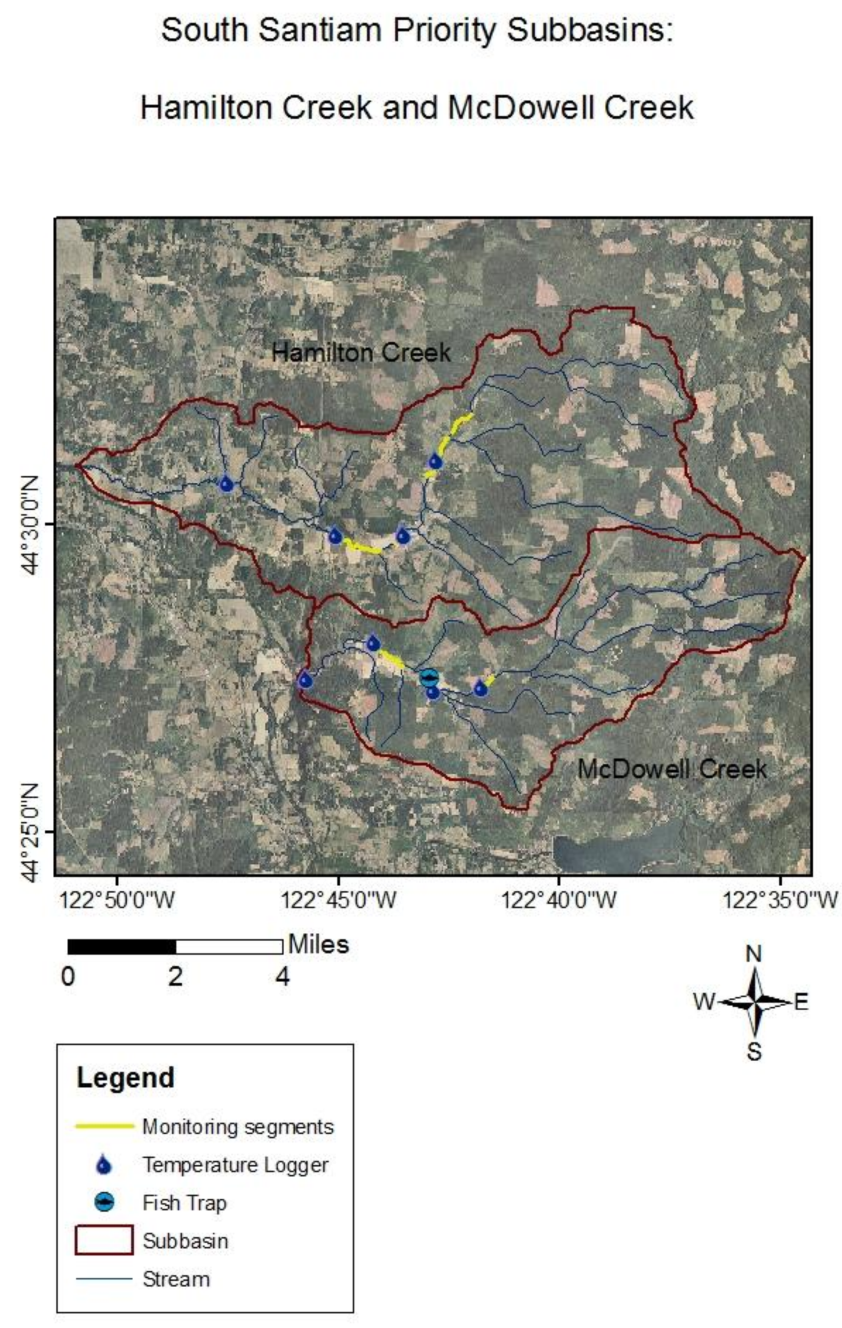


Figure 2. Map of the South Santiam Watershed Council's priority subbasins and monitoring locations.

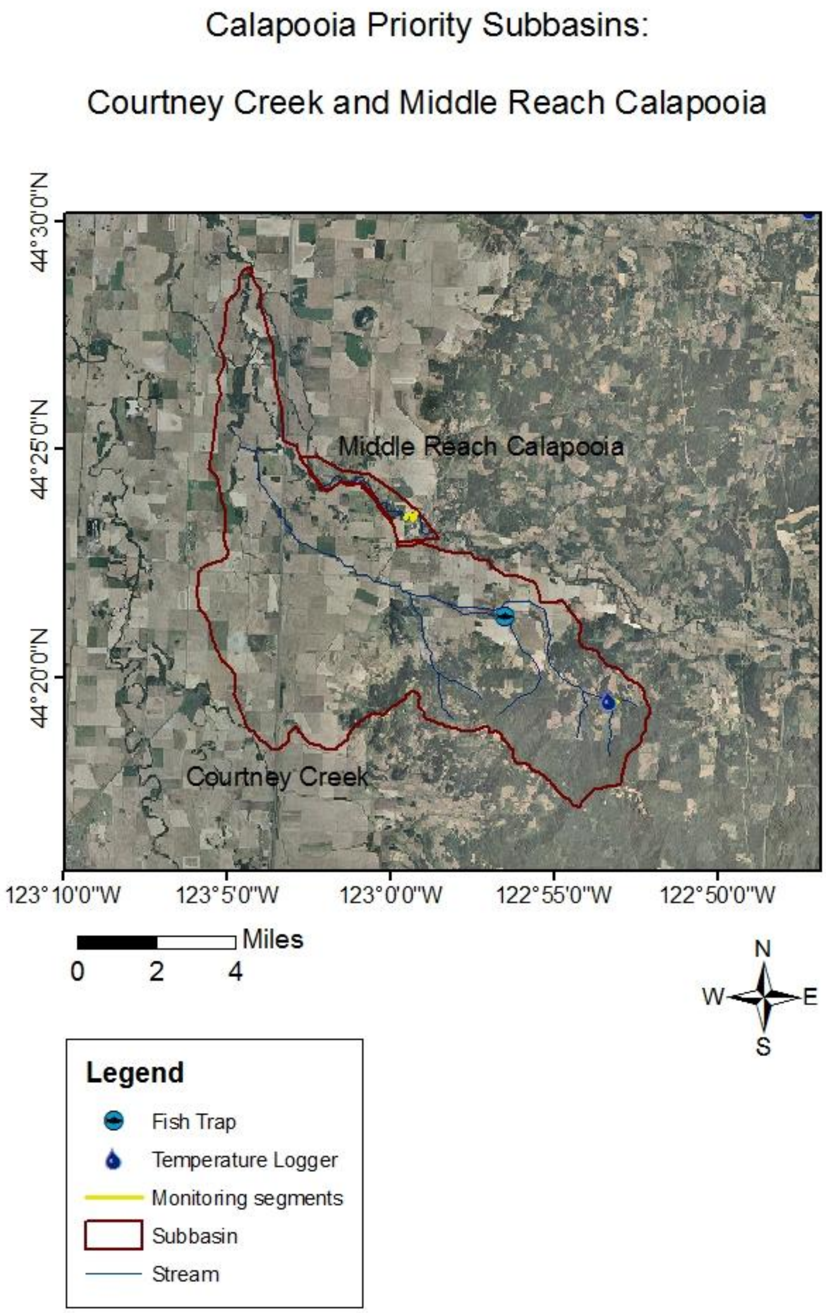
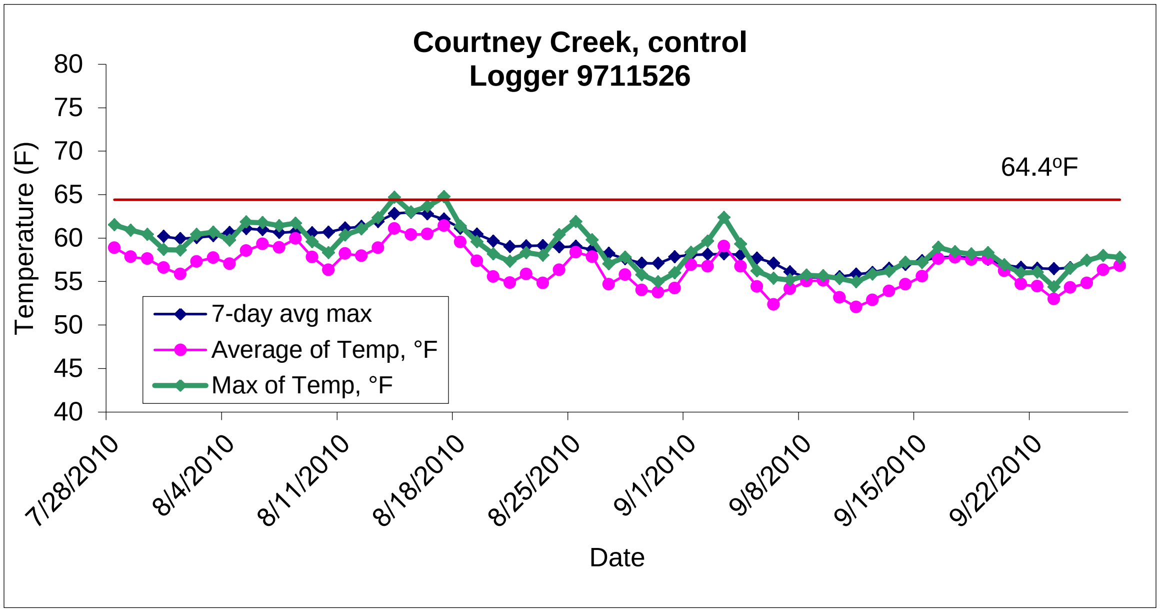
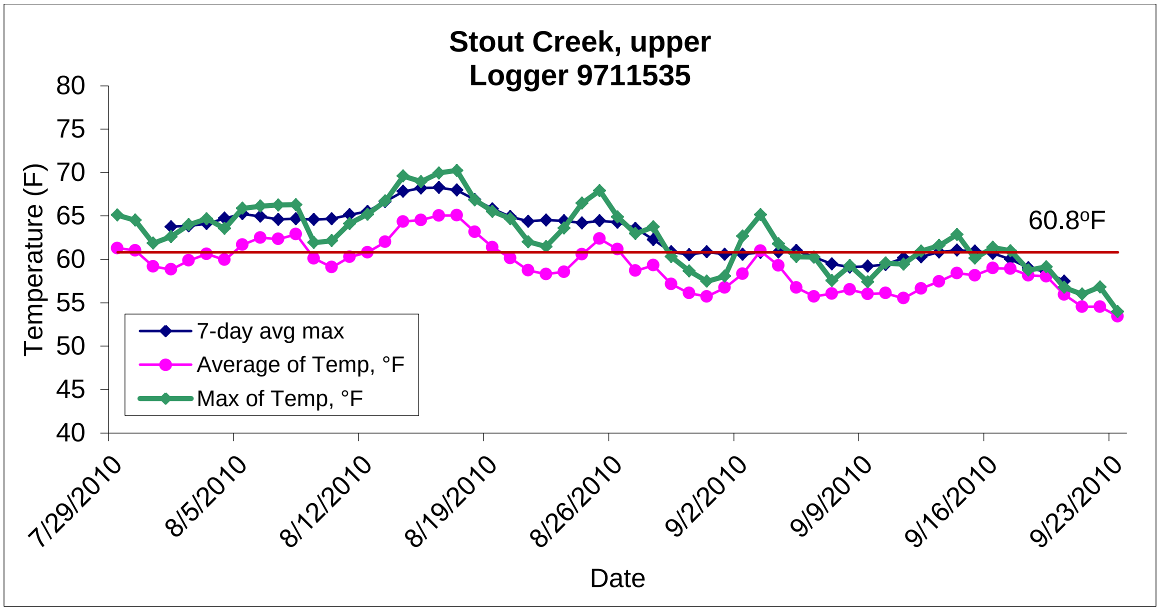


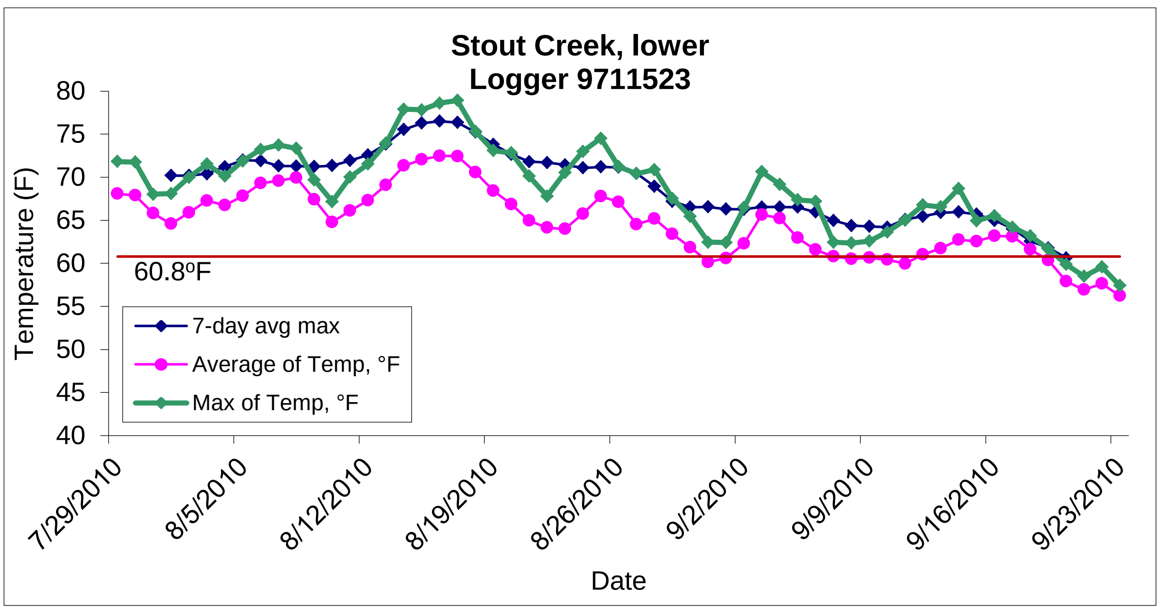
Figure 3. Map of the Calapooia Watershed Council's priority subbasins and monitoring locations.

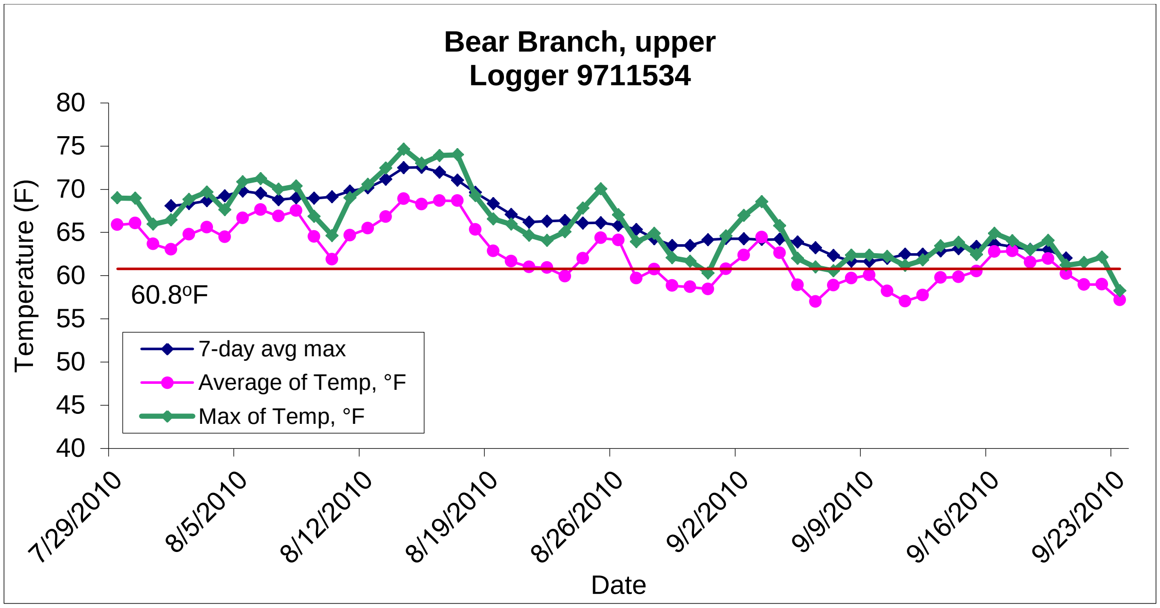
Appendix A

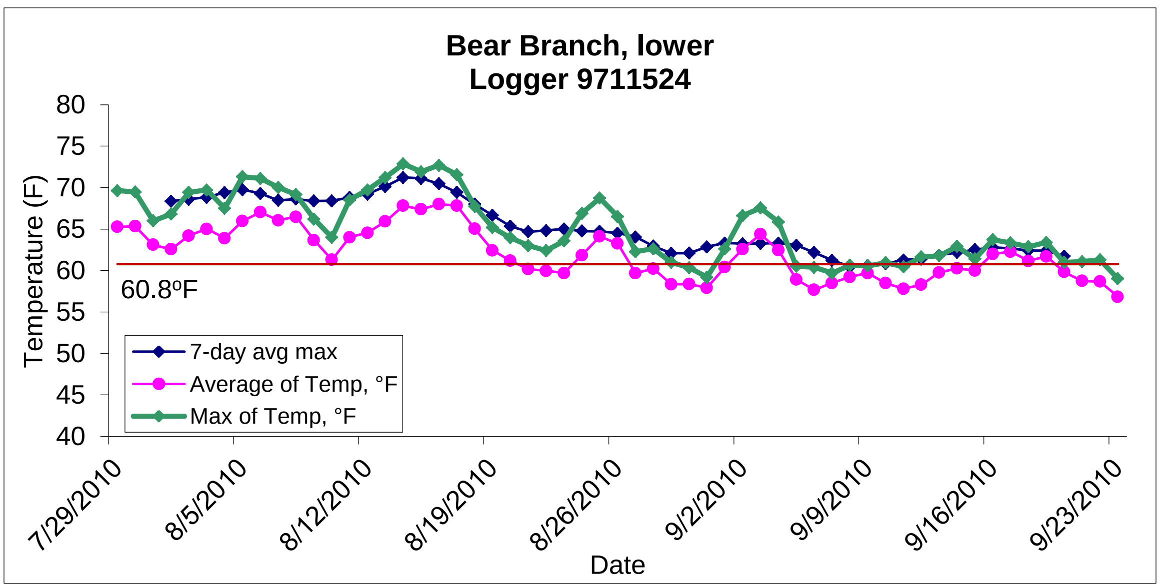
Results of individual temperature loggers. Not all treatment segments had temperature loggers placed in the stream. The actual number of days that recorded water temperture varied amongst loggers.

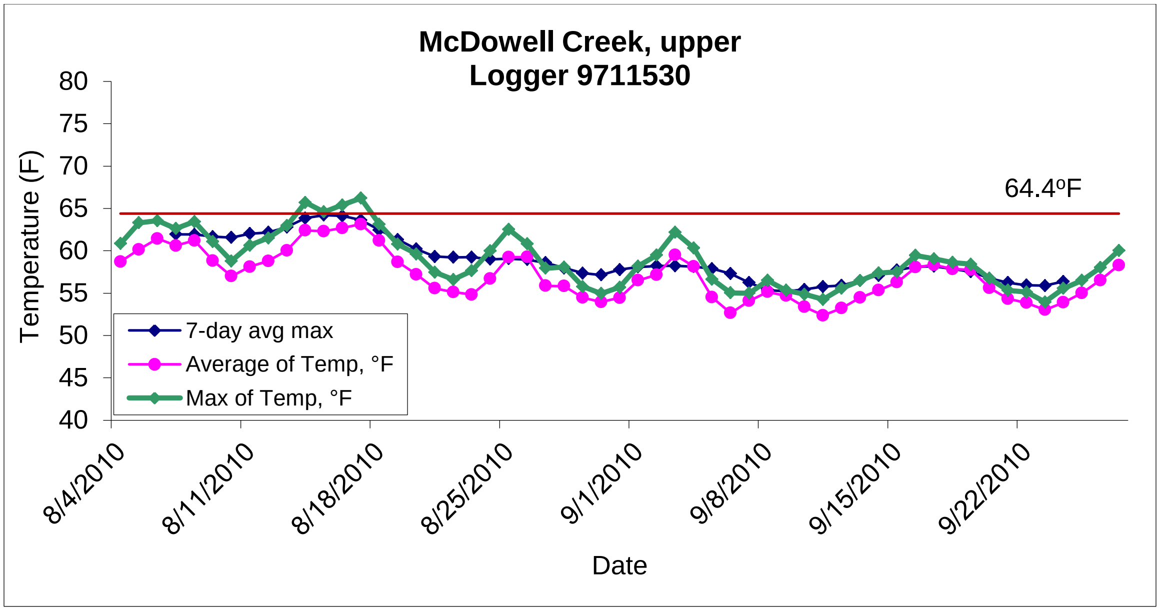


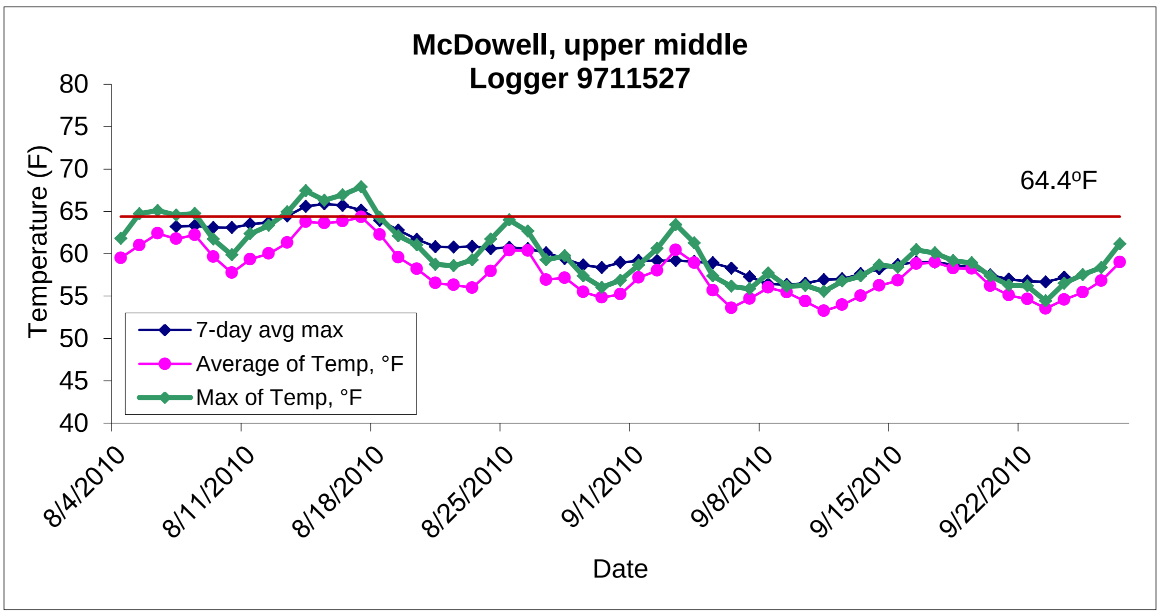

Stout Creek, upper
Logger 9711535
Temperature (F)
80
75
70
65
60
55
50
45
40
60.8ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
7/29/2010
8/5/2010
8/12/2010
8/19/2010
8/26/2010
9/2/2010
9/9/2010
9/16/2010
9/23/2010
Date

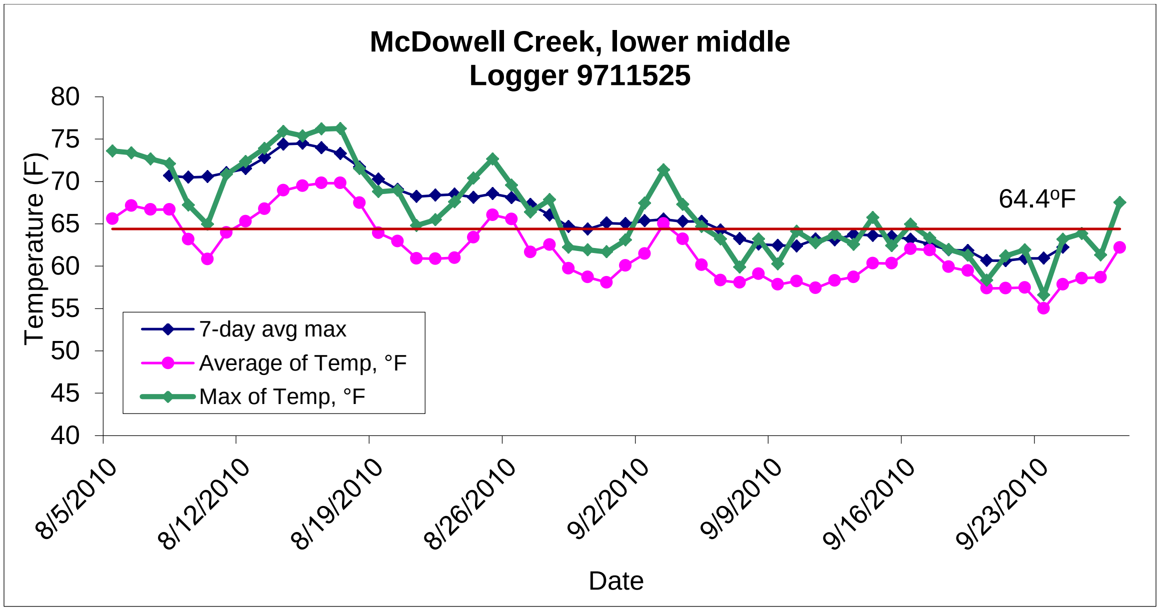

Stout Creek, lower
Logger 9711523
Temperature (F)
80
75
70
65
60
55
50
45
40
60.8ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
7/29/2010
8/5/2010
8/12/2010
8/19/2010
8/26/2010
9/2/2010
9/9/2010
9/16/2010
9/23/2010
Date

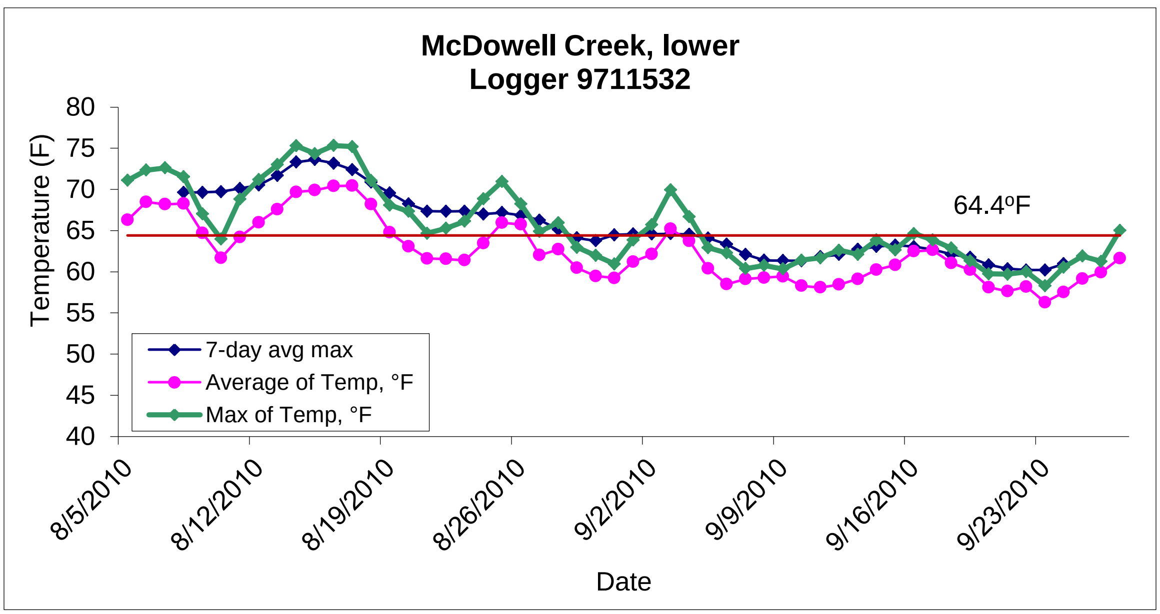

Bear Branch, upper
Logger 9711534
Temperature (F)
80
75
70
65
60
55
50
45
40
60.8ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
7/29/2010
8/5/2010
8/12/2010
8/19/2010
8/26/2010
9/2/2010
9/9/2010
9/16/2010
9/23/2010
Date

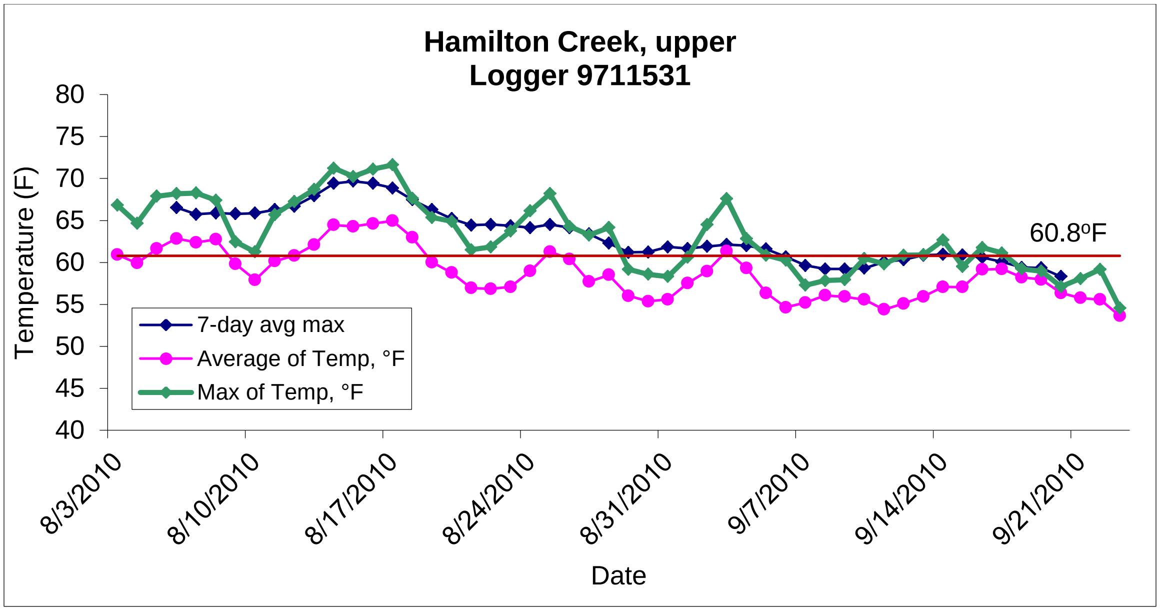

Bear Branch, lower
Logger 9711524
Temperature (F)
80
75
70
65
60
55
50
45
40
60.8ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
7/29/2010
8/5/2010
8/12/2010
8/19/2010
8/26/2010
9/2/2010
9/9/2010
9/16/2010
9/23/2010
Date

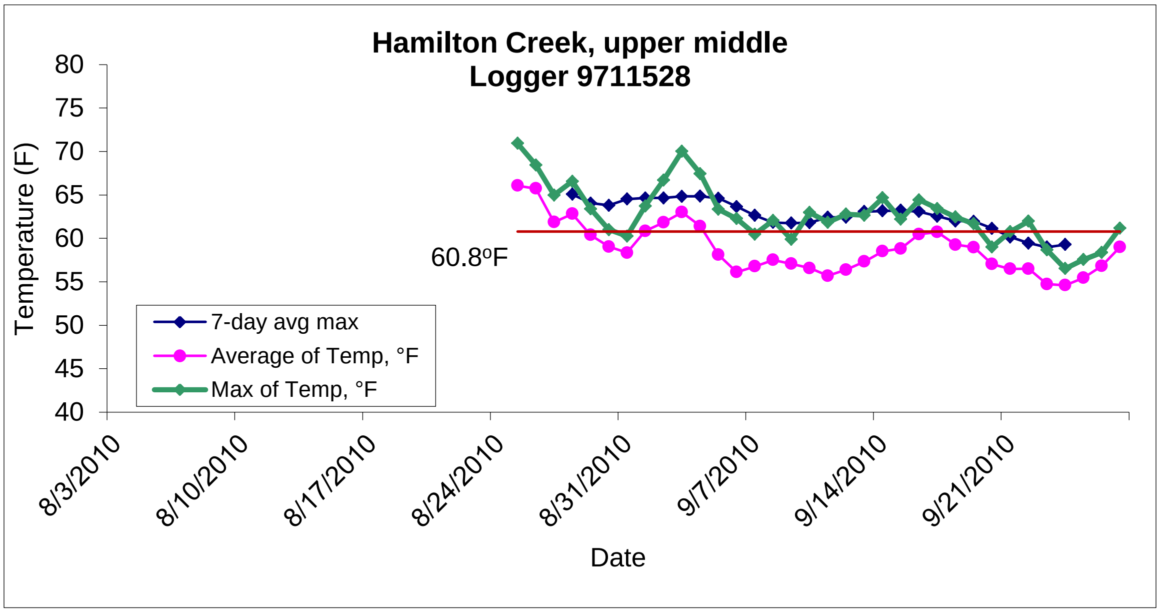

McDowell Creek, upper
Logger 9711530
80
75
70
65
60
55
50
45
40
Temperature (F)
64.4ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
8/4/2010
8/11/2010
8/18/2010
8/25/2010
9/1/2010
9/8/2010
9/15/2010
9/22/2010
Date

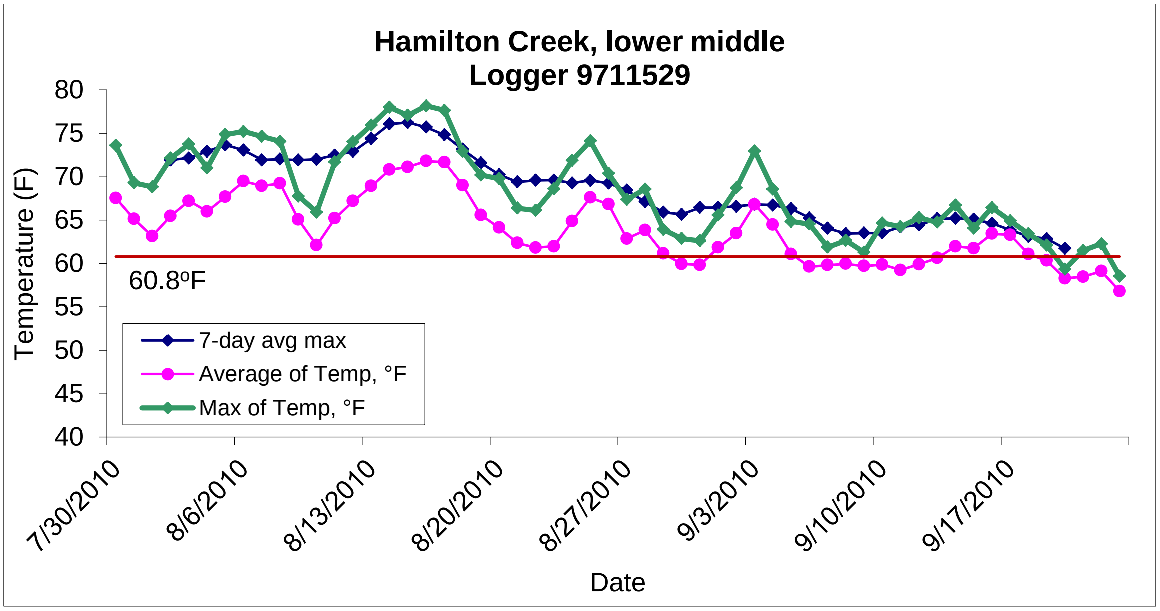

McDowell, upper middle
Logger 9711527
80
75
70
65
60
55
50
45
40
Temperature (F)
64.4ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
8/4/2010
8/11/2010
8/18/2010
8/25/2010
9/1/2010
9/8/2010
9/15/2010
9/22/2010
Date

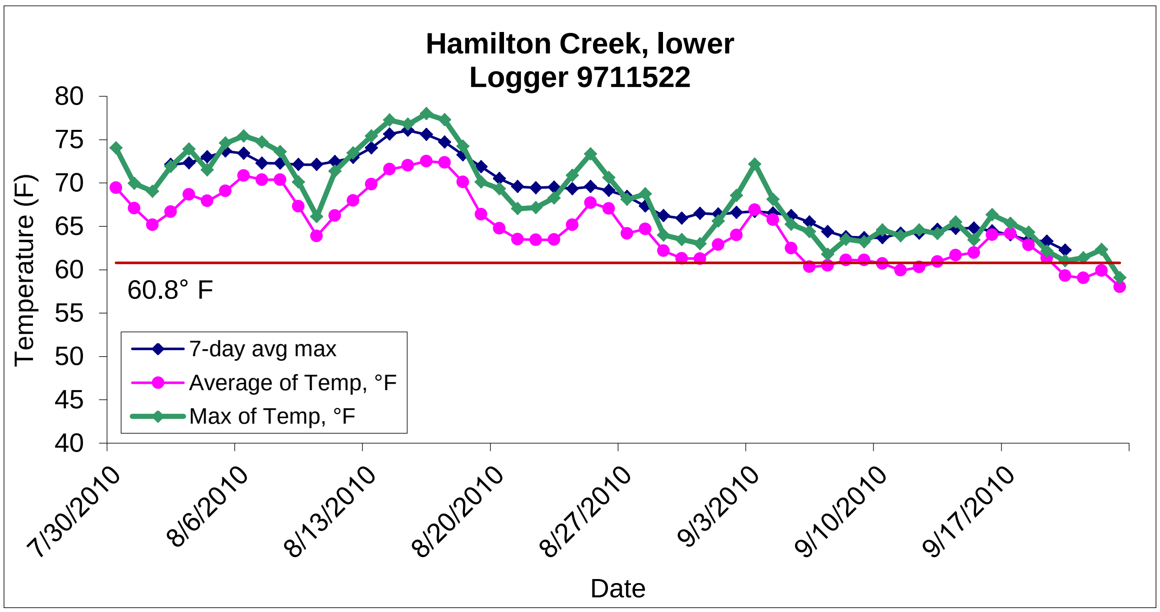

McDowell Creek, lower middle
Logger 9711525
Temperature (F)
80
75
70
65
60
55
50
45
40
64.4ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
8/5/2010
8/12/2010
8/19/2010
8/26/2010
9/2/2010
9/9/2010
9/16/2010
9/23/2010
Date


McDowell Creek, lower
Logger 9711532
Temperature (F)
80
75
70
65
60
55
50
45
40
64.4ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
8/5/2010
8/12/2010
8/19/2010
8/26/2010
9/2/2010
9/9/2010
9/16/2010
9/23/2010
Date


Hamilton Creek, upper
Logger 9711531
80
75
70
65
60
55
50
45
40
Temperature (F)
60.8ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
8/3/2010
8/10/2010
8/17/2010
8/24/2010
8/31/2010
9/7/2010
9/14/2010
9/21/2010
Date

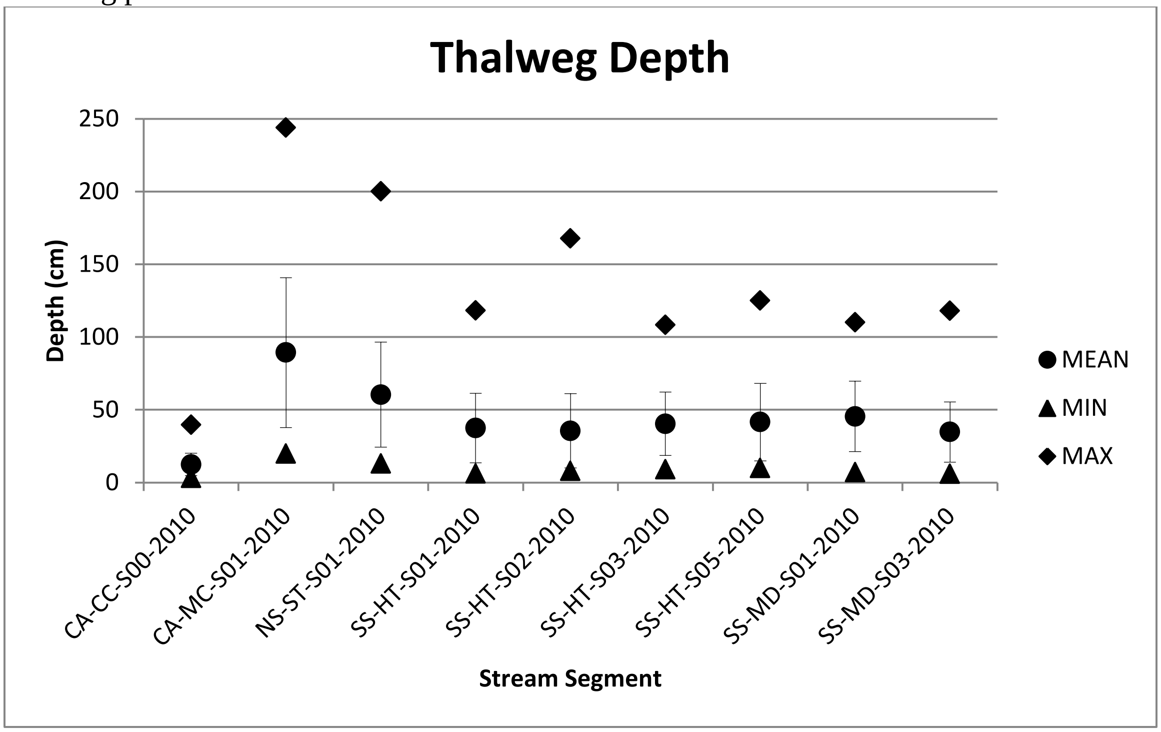

Hamilton Creek, upper middle
Logger 9711528
80
75
70
65
60
55
50
45
40
Temperature (F)
60.8ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
8/3/2010
8/10/2010
8/17/2010
8/24/2010
8/31/2010
9/7/2010
9/14/2010
9/21/2010
Date


Hamilton Creek, lower middle
Logger 9711529
Temperature (F)
80
75
70
65
60
55
50
45
40
60.8ºF
7-day avg max
Average of Temp, °F
Max of Temp, °F
7/30/2010
8/6/2010
8/13/2010
8/20/2010
8/27/2010
9/3/2010
9/10/2010
9/17/2010
Date

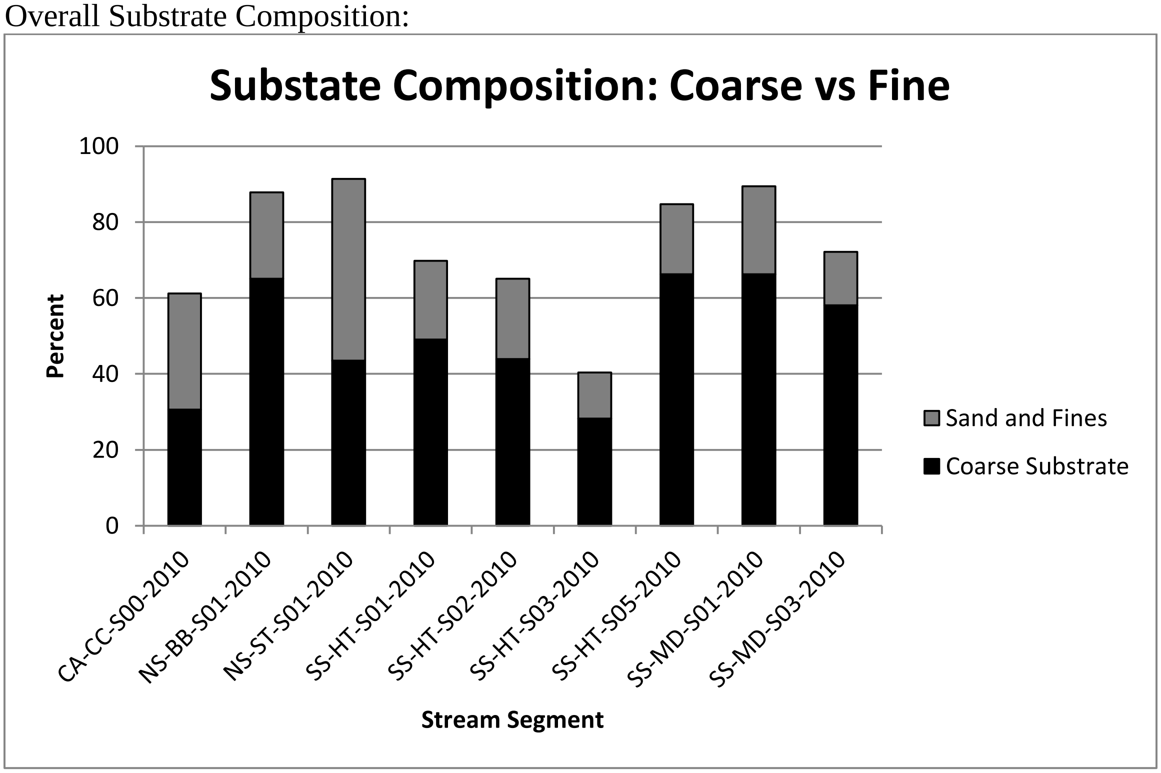

Hamilton Creek, lower
Logger 9711522
Temperature (F)
80
75
70
65
60
55
50
45
40
60.8° F
7-day avg max
Average of Temp, °F
Max of Temp, °F
7/30/2010
8/6/2010
8/13/2010
8/20/2010
8/27/2010
9/3/2010
9/10/2010
9/17/2010
Date

Appendix B
Summary data for all stream segments is depicted in graph form. Error bars on any graph denote one standard deviation.

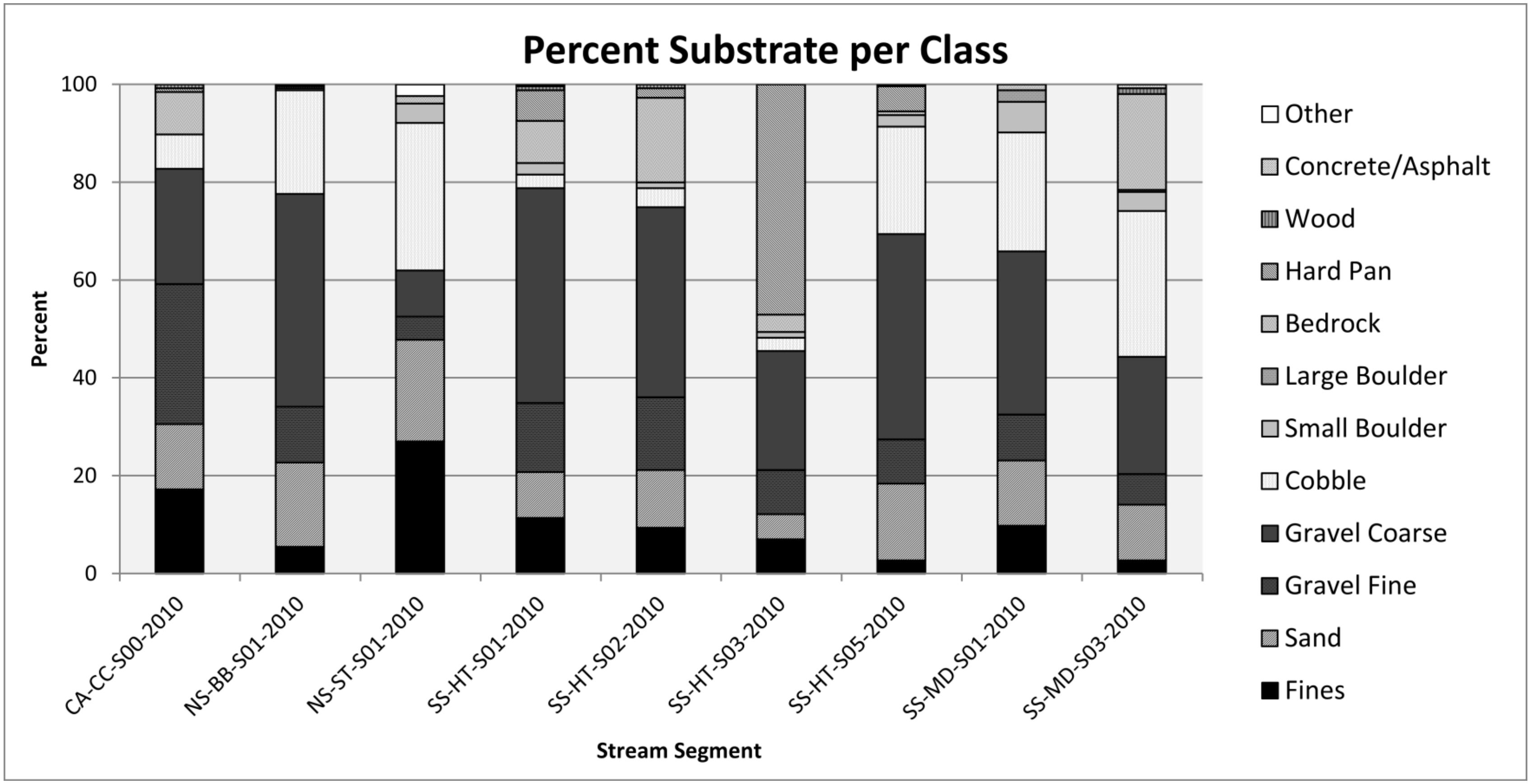
Thalweg profile all sites:



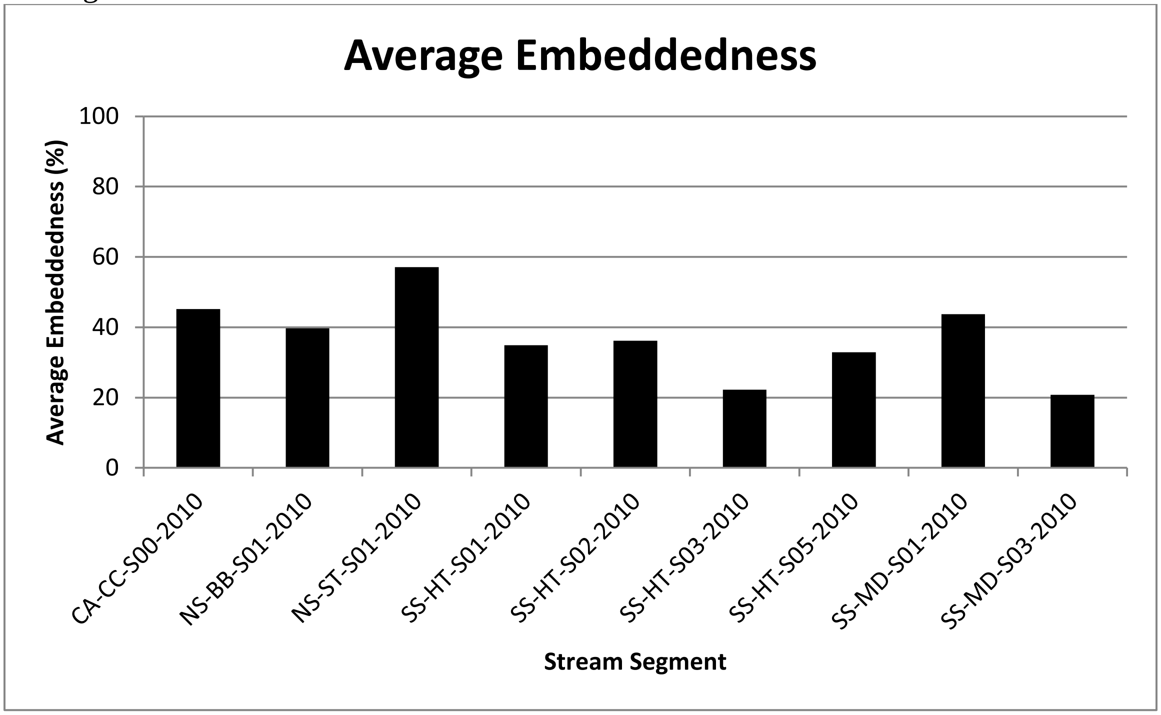
Overall Substrate Composition:



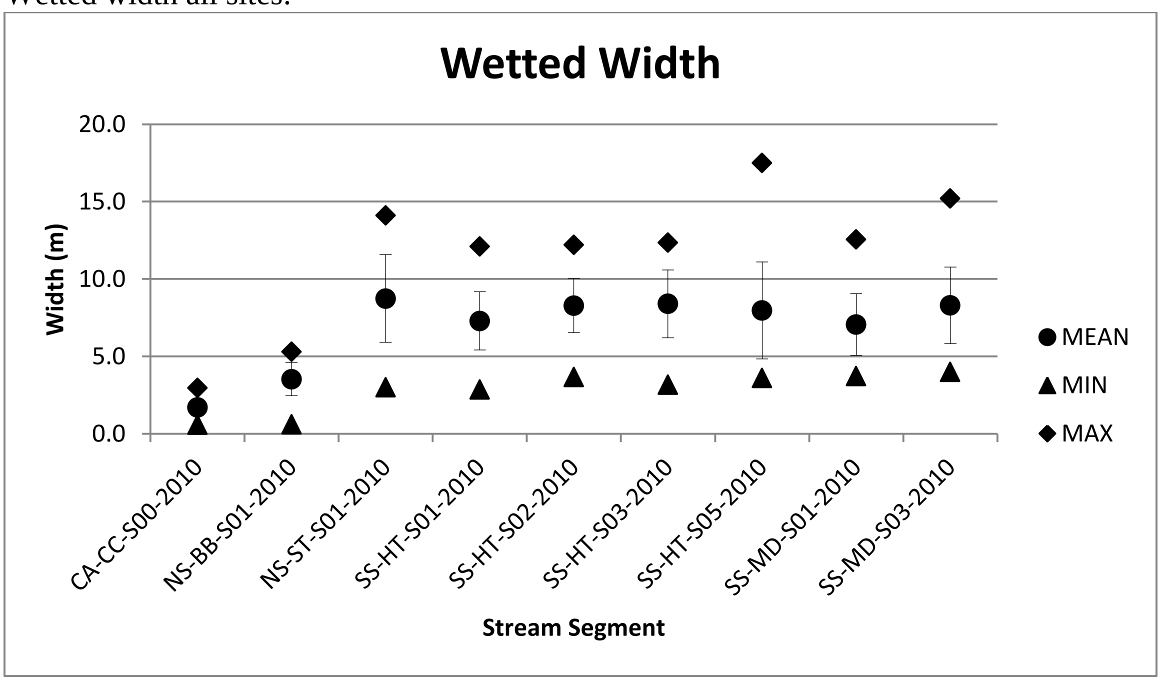
Substrate characterization for stream segments:



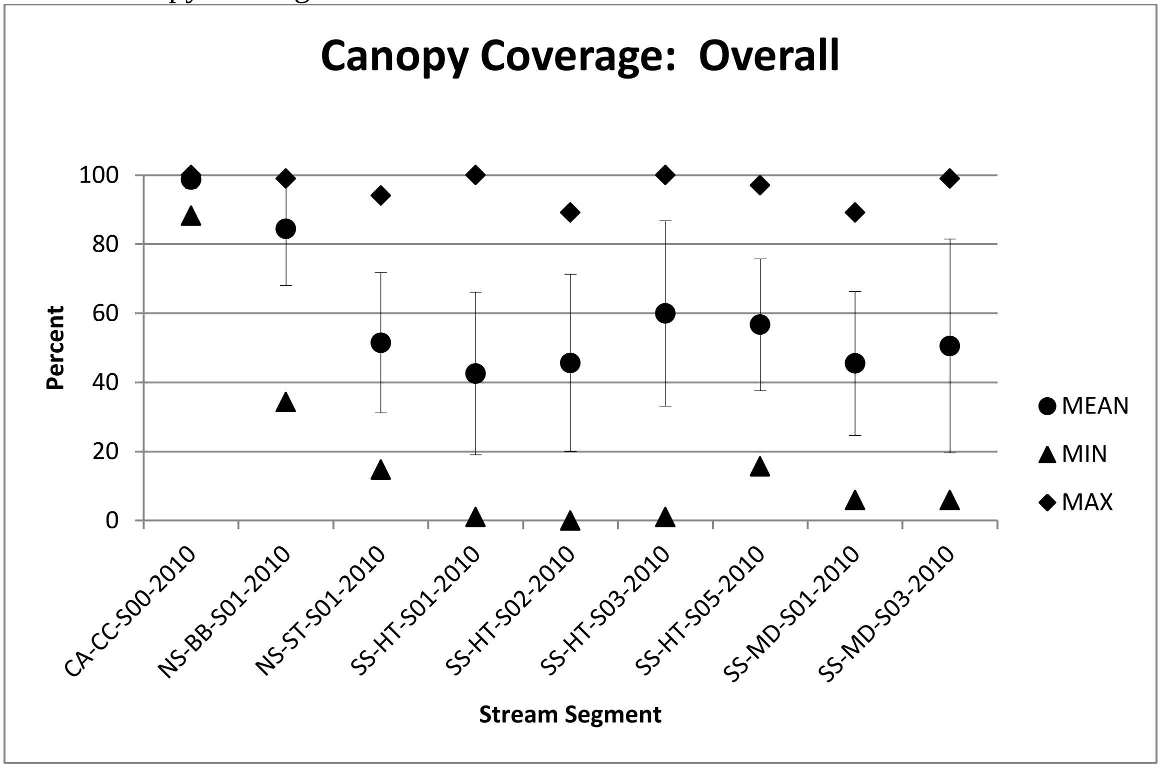
Average embeddedness of substrate:



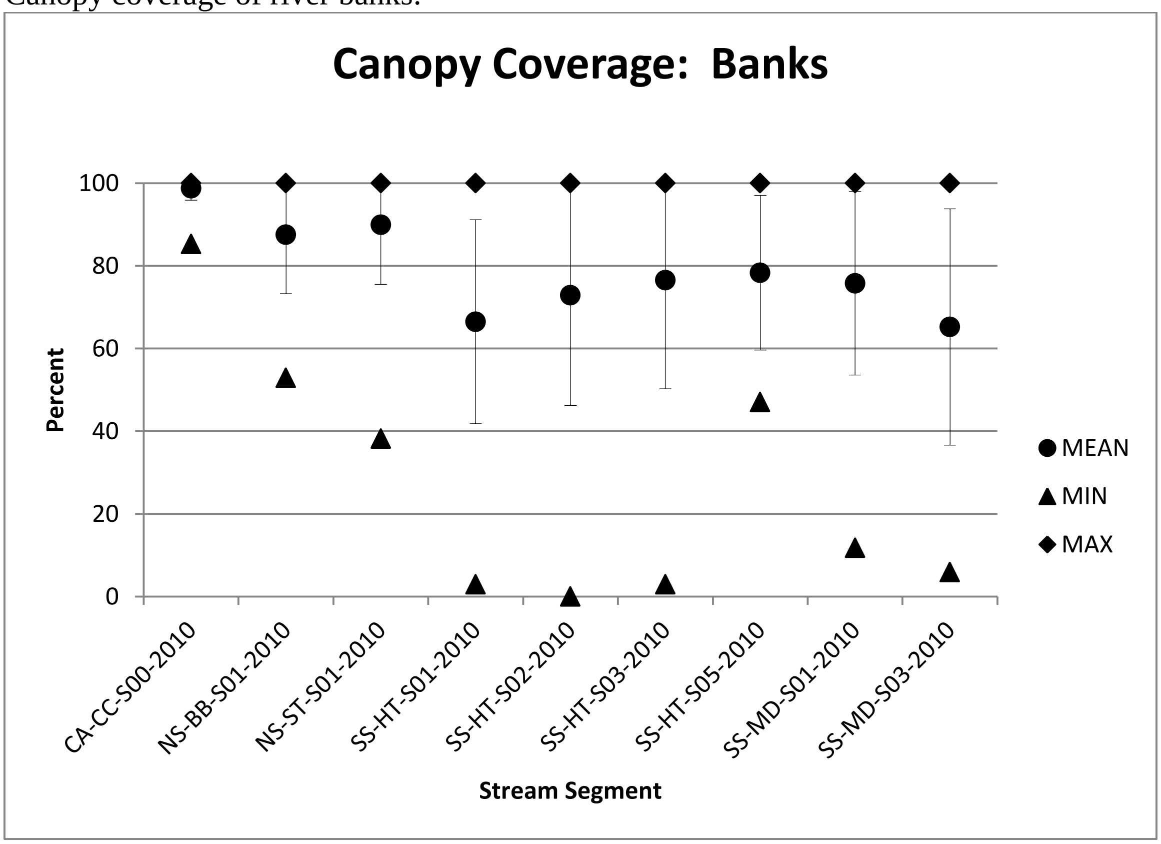
Wetted width all sites:



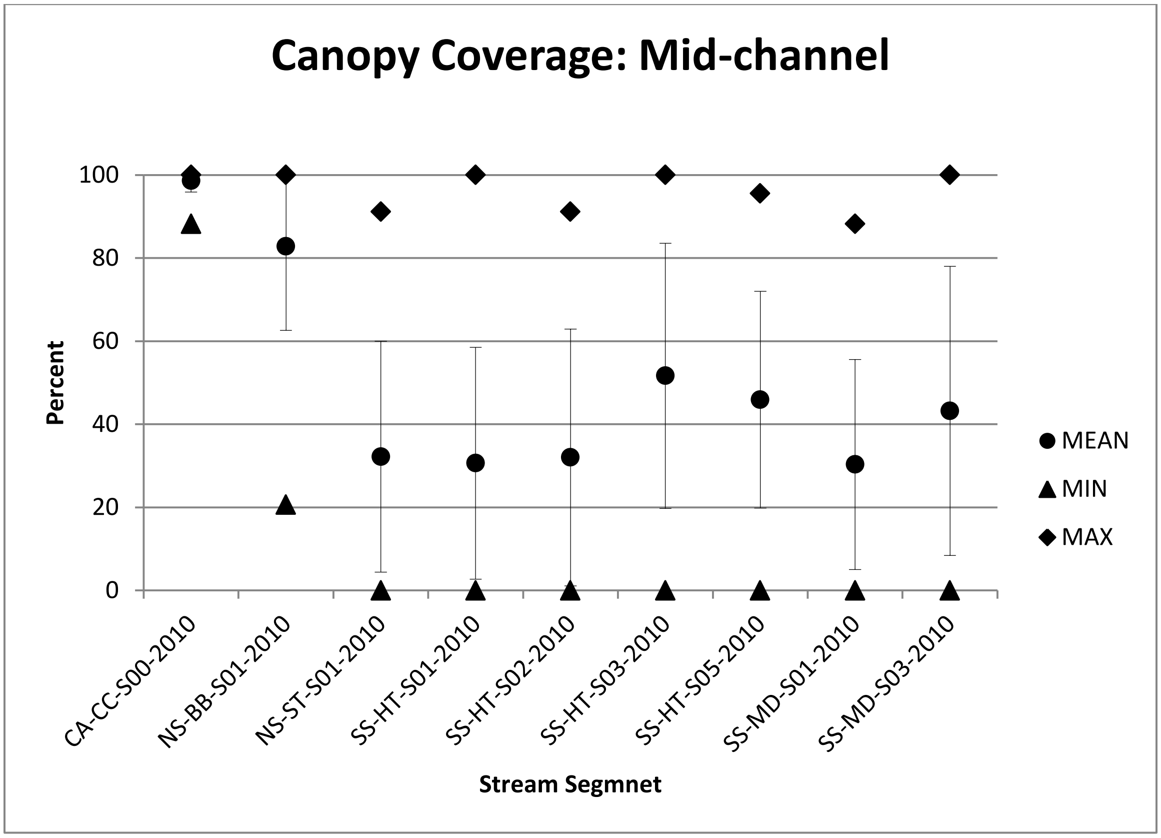
Overall canopy coverage:



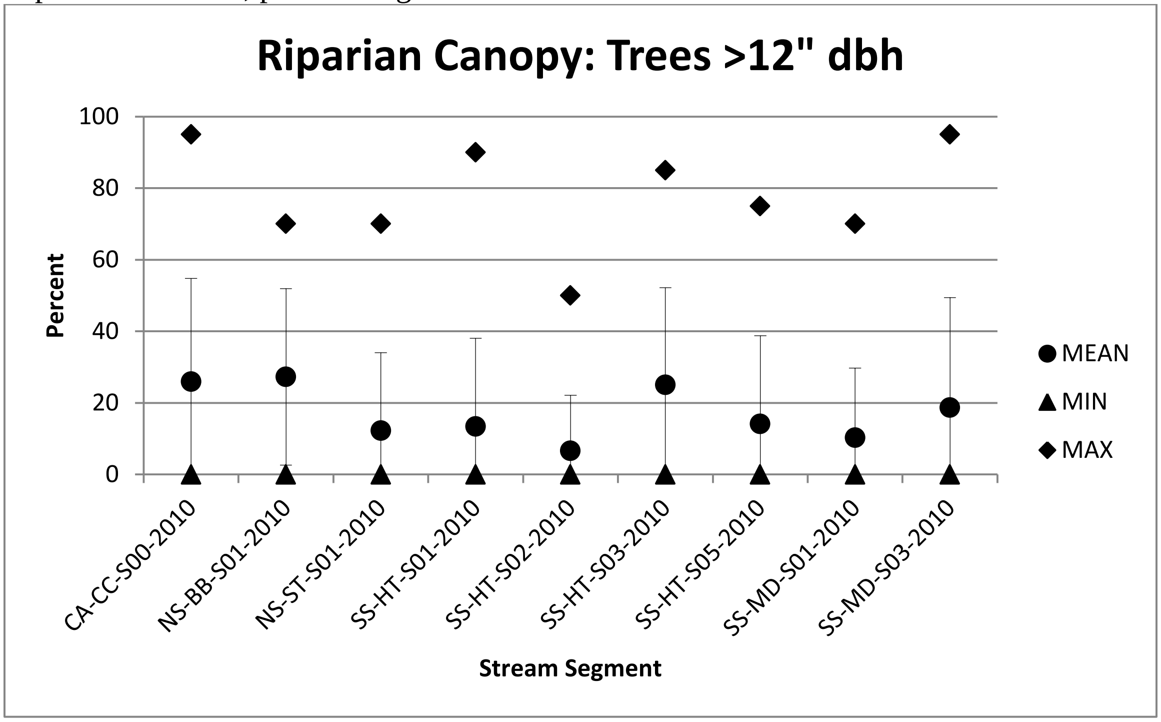
Canopy coverage of river banks:



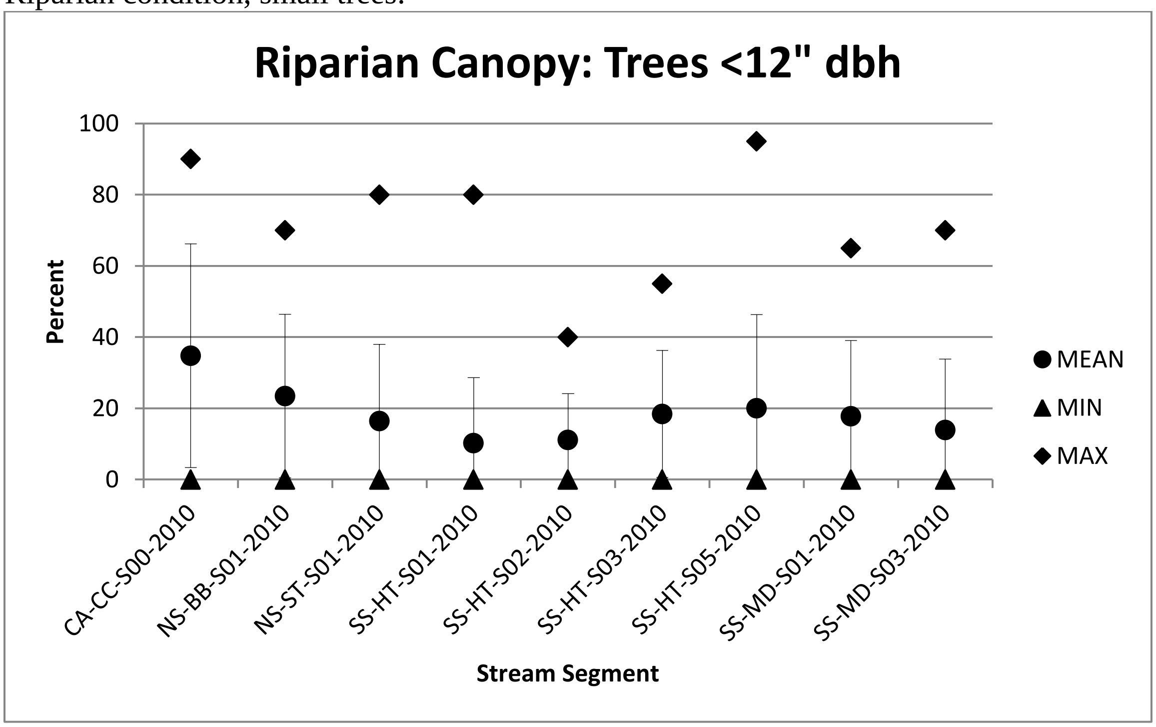
Canopy coverage at streams mid channel:



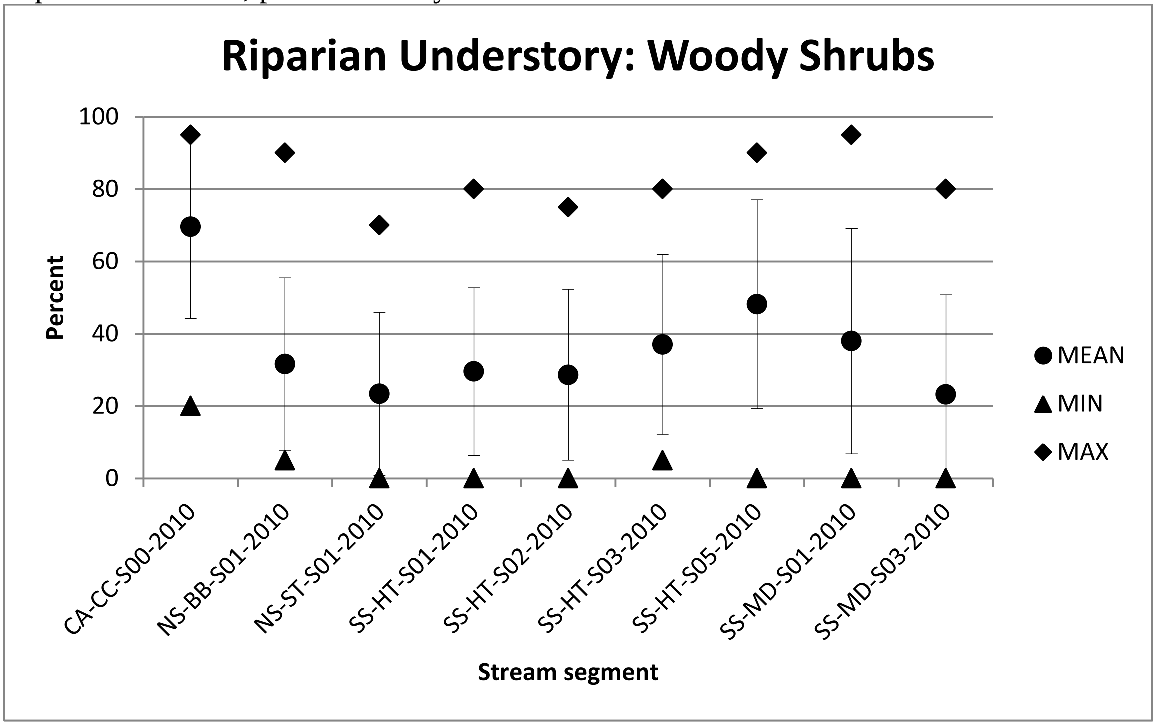
Riparian condition, percent large trees:



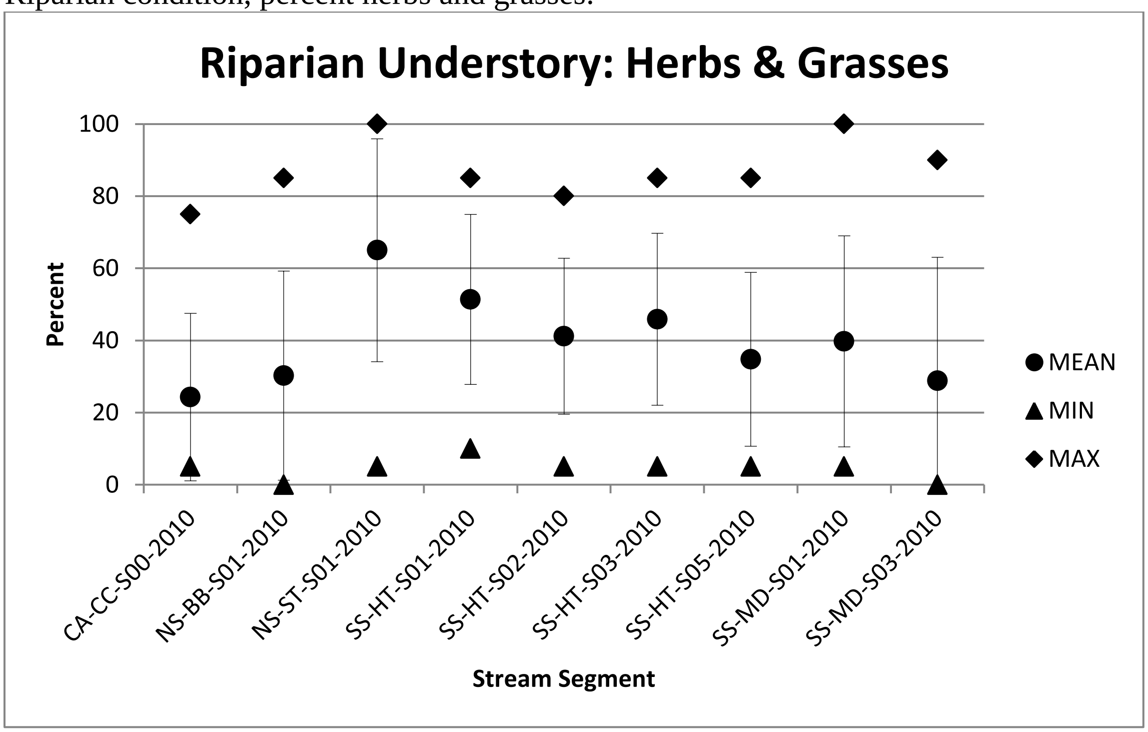
Riparian condition, small trees:



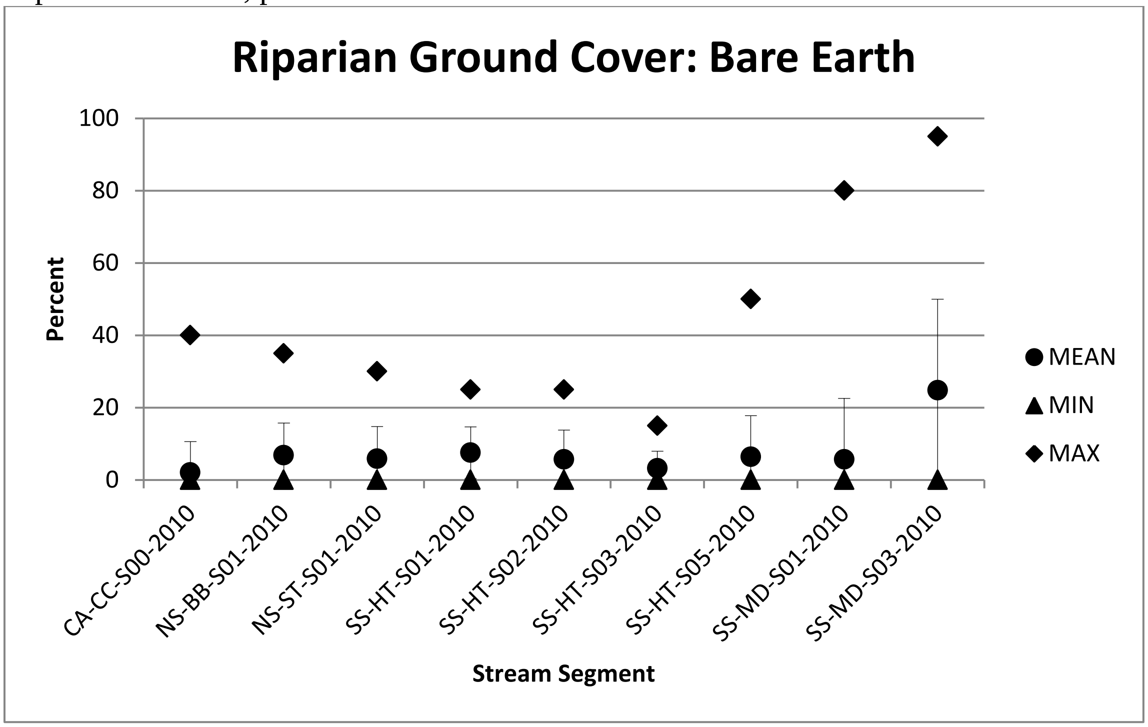
Riparian condition, percent woody shrubs:



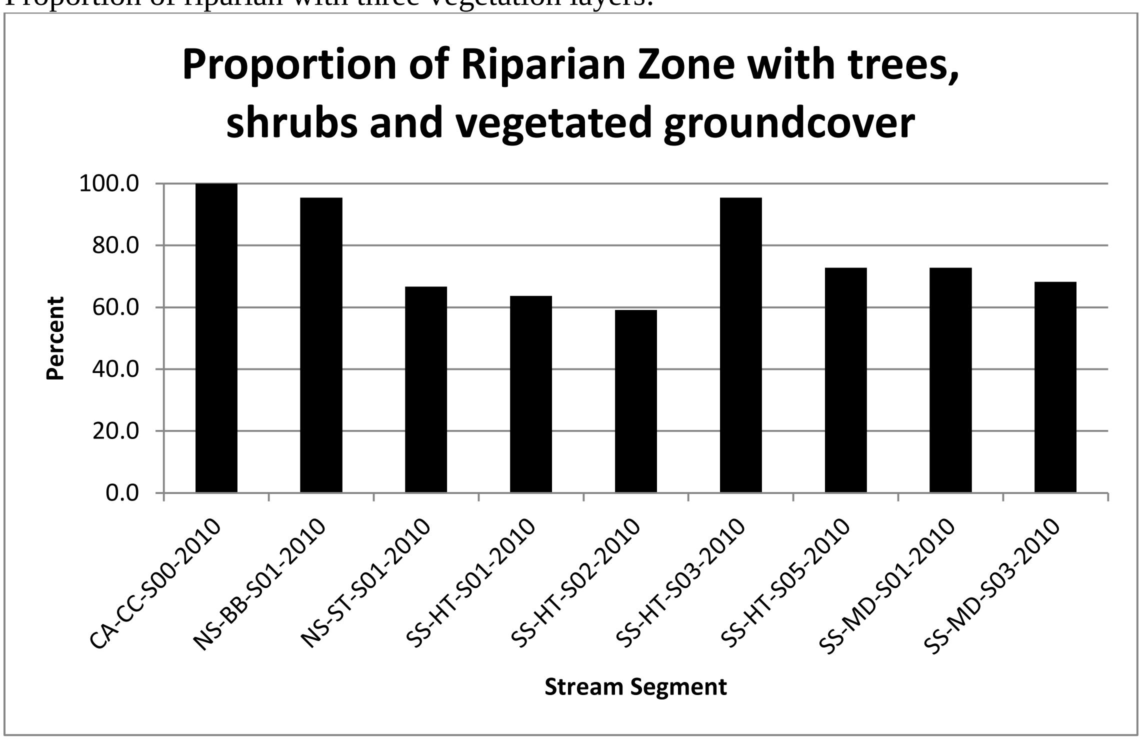
Riparian condition, percent herbs and grasses:



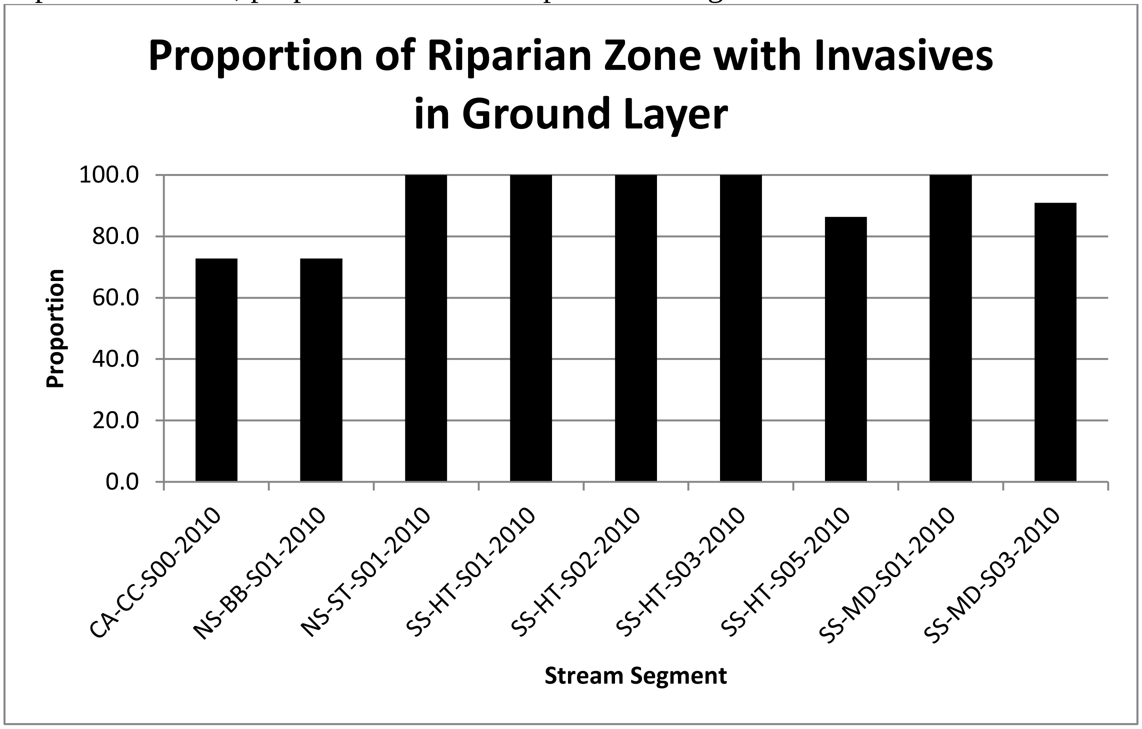
Riparian condition, percent bare earth:



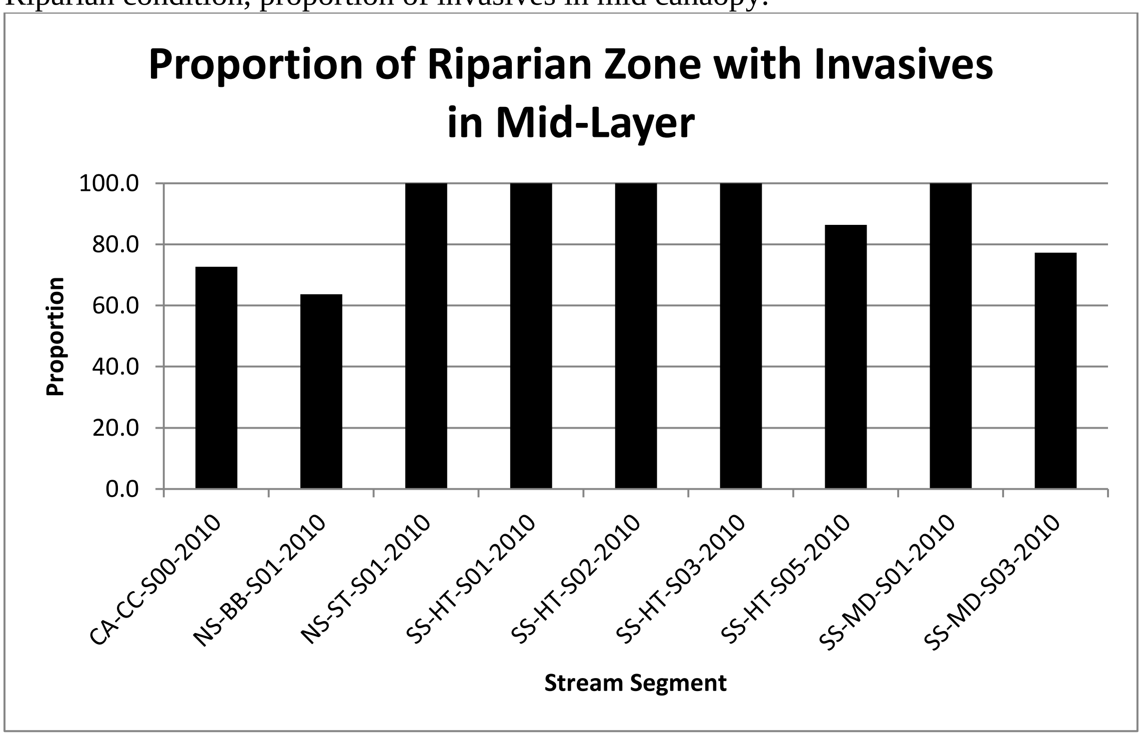
Proportion of riparian with three vegetation layers:



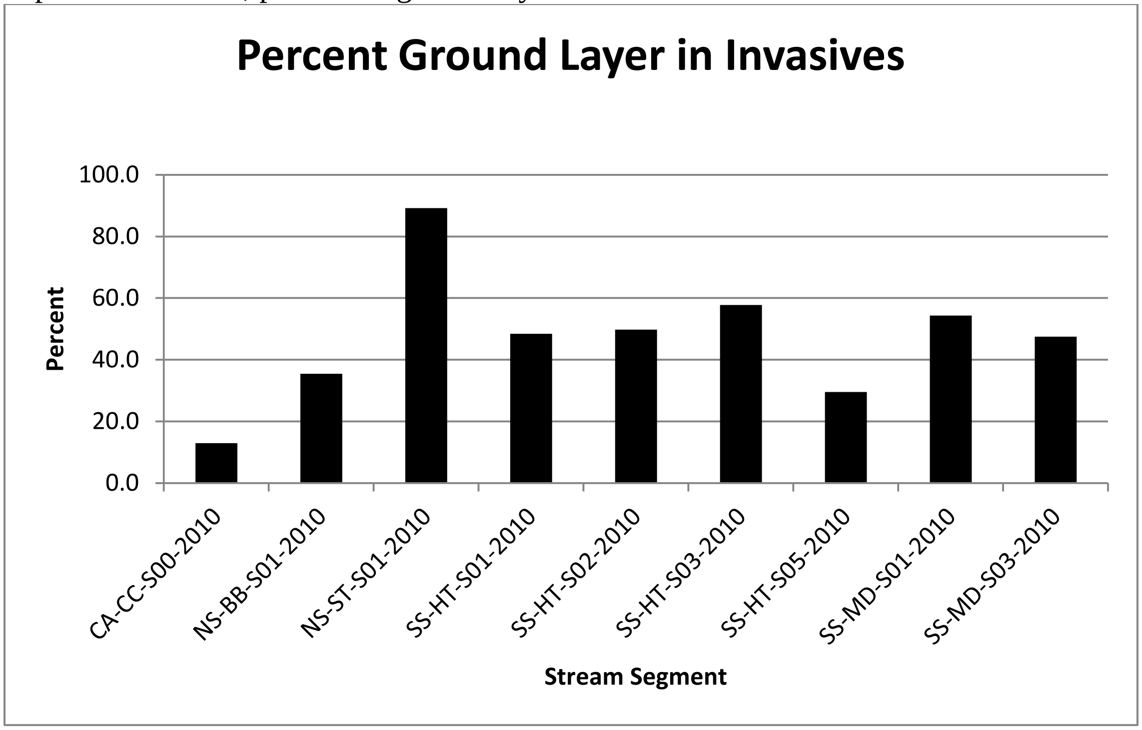
Riparian condtion, proportion of invasive plants in the ground cover:



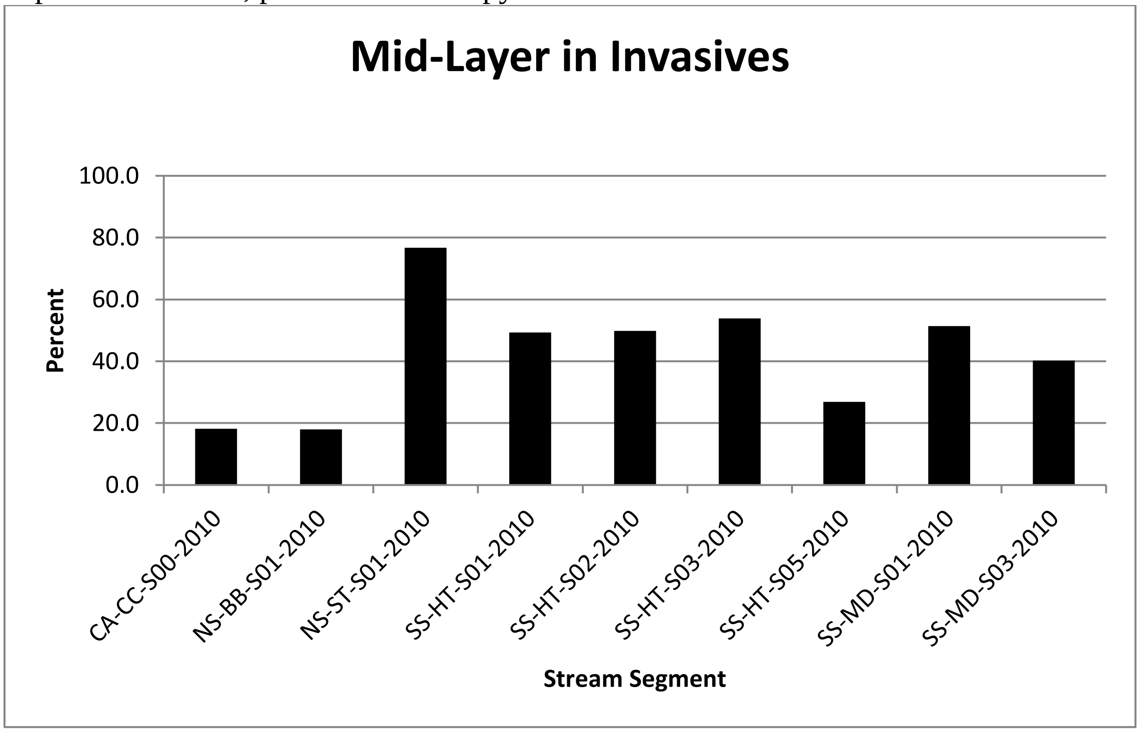
Riparian condition, proportion of invasives in mid canaopy:



Riparian condition, percent of ground layer in invasives:



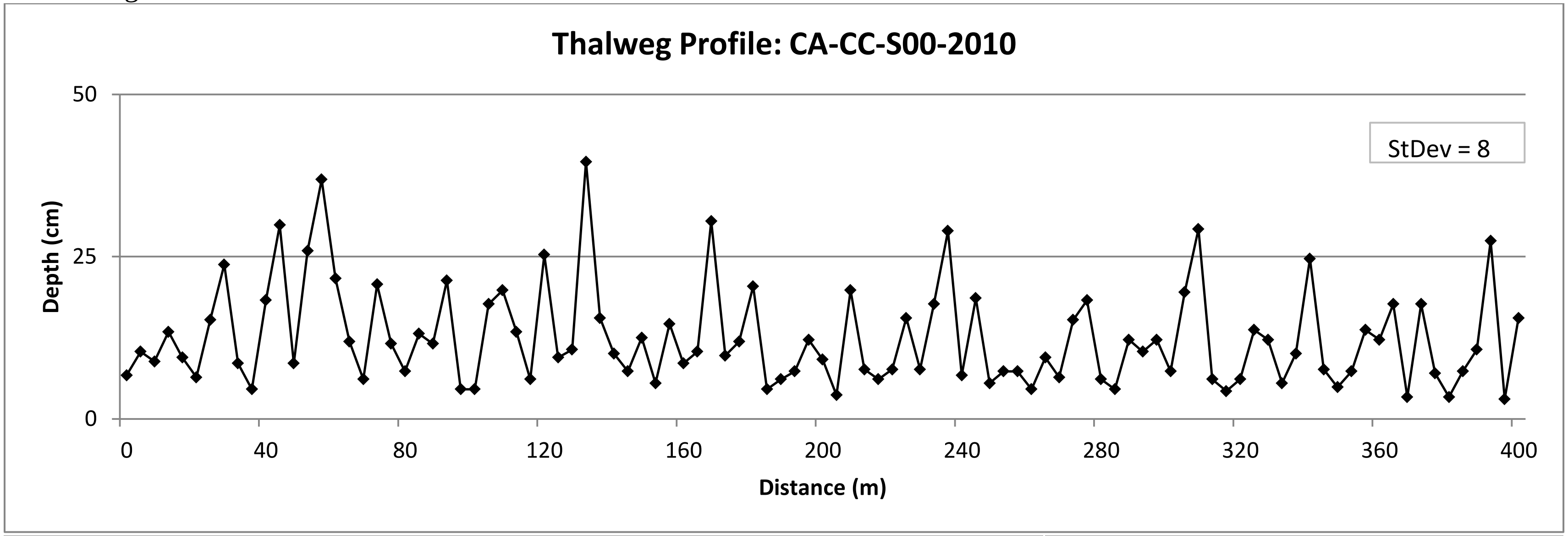
Riparian condition, percent mid-canopy in invasives:

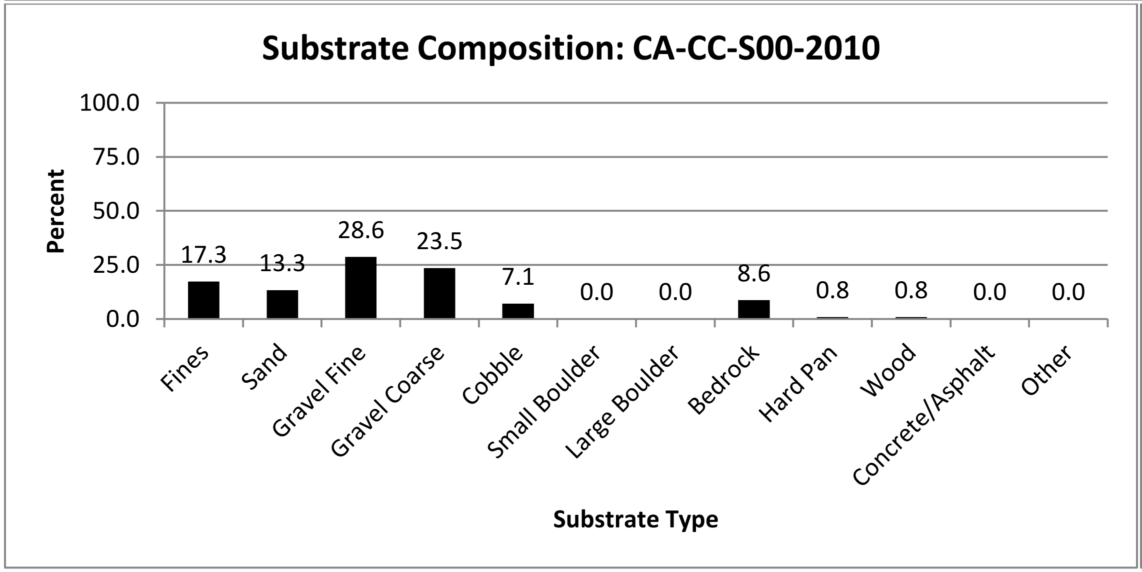


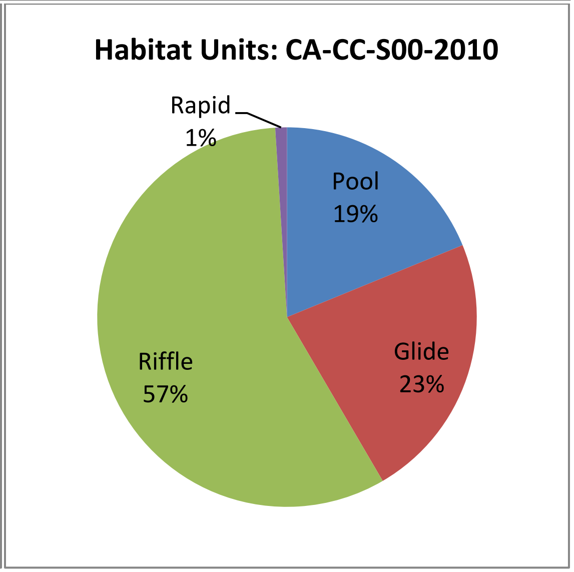
Macroinvertebrate Observed/Expected scores:

		P > 0.5		
Segment	**MODEL**	**O**	**E**	**O/E**
SS-HT-S05-2010 #1	WCCP	19	17.65	1.08
SS-HT-S05-2010 #1 DUP	WCCP	18	17.65	1.02
SS-HT-S01-2010 #1	MWCF	19	20.88	0.91
SS-HT-S01-2010 #1 DUP	MWCF	17	20.88	0.81
SS-HT-S00-2010	WCCP	20	17.65	1.13

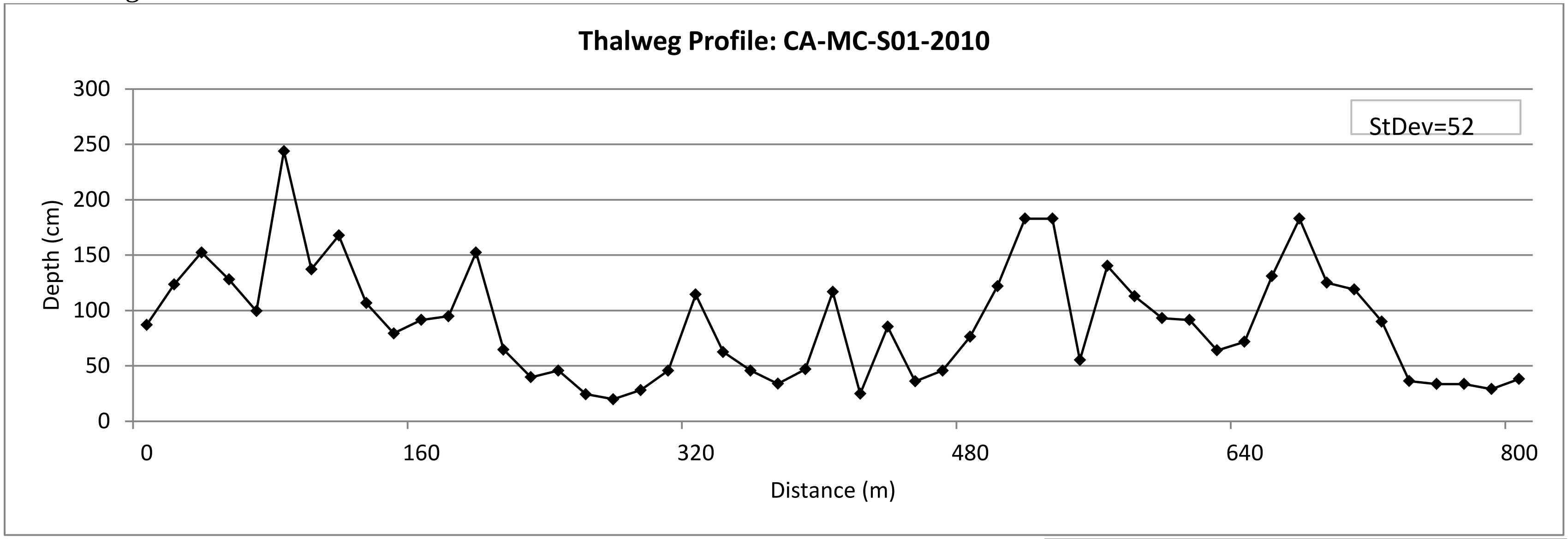
Appendix C
Details for stream segment thalweg profile, substrate characterization and habitat units.
Stream Segment: CA-CC-S00-2010



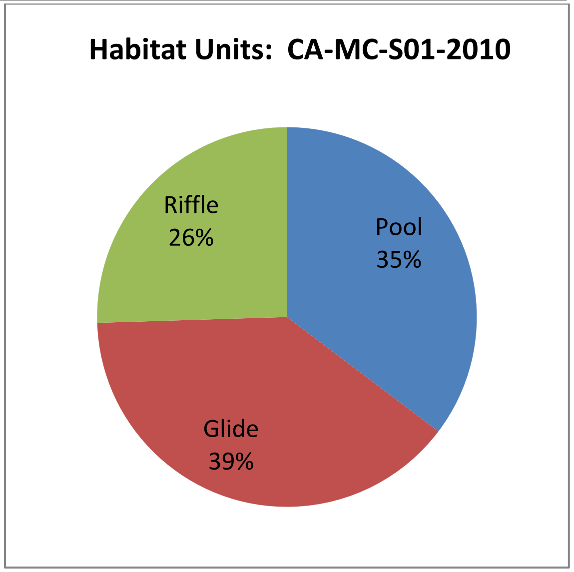




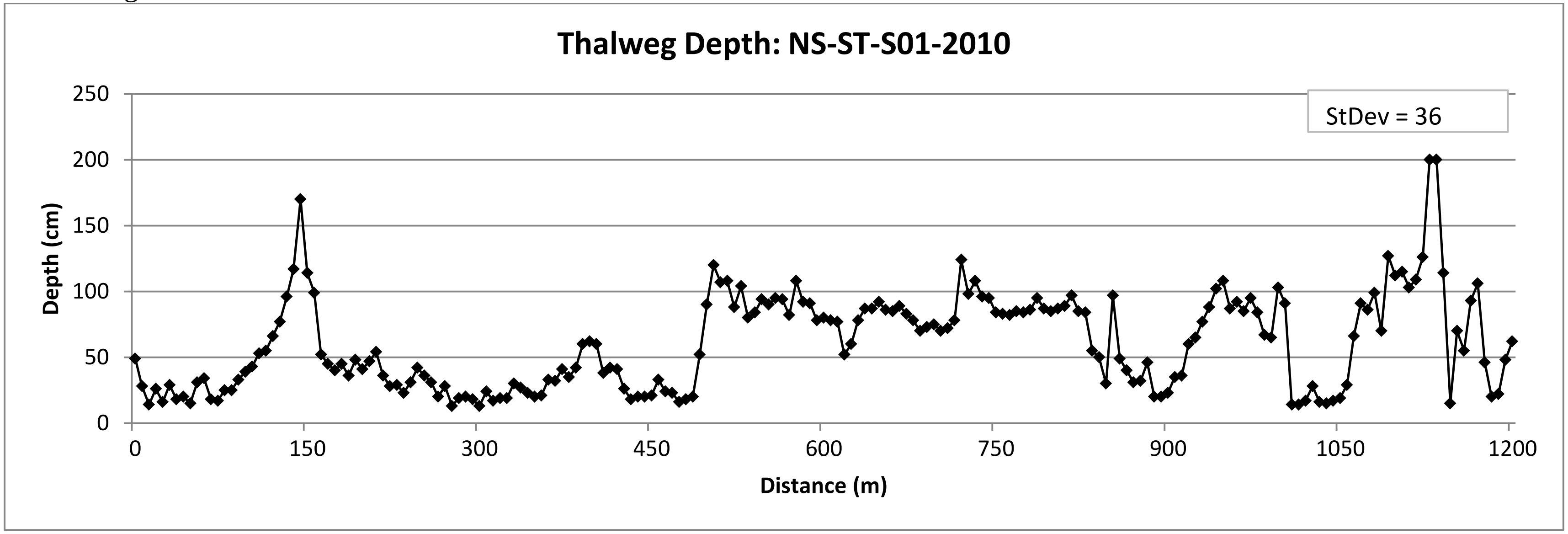
Stream Segment: CA-MC-S01-2010

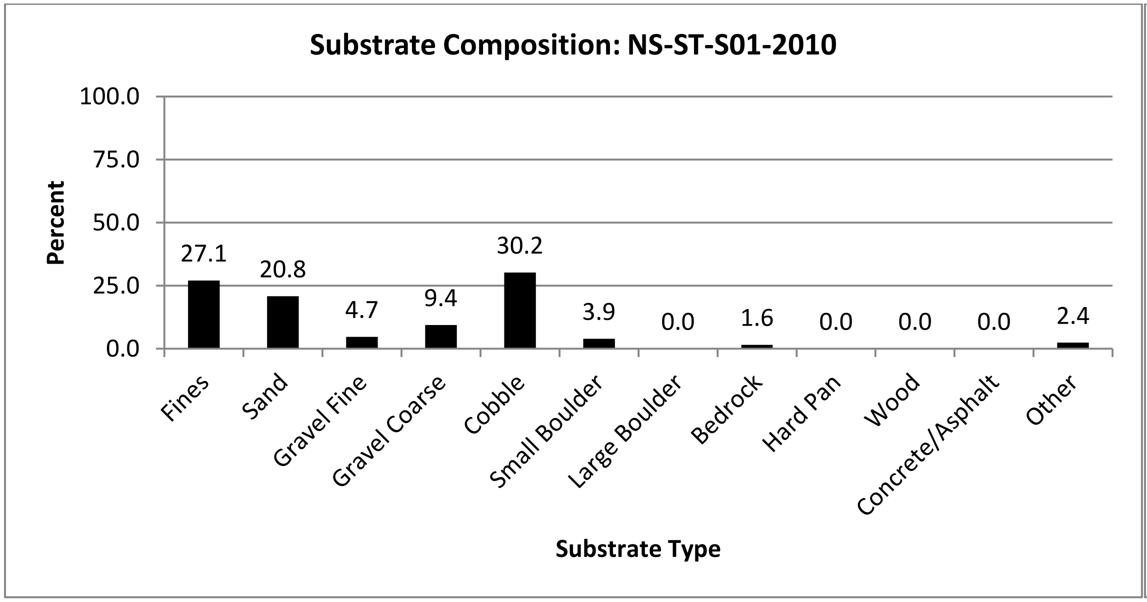


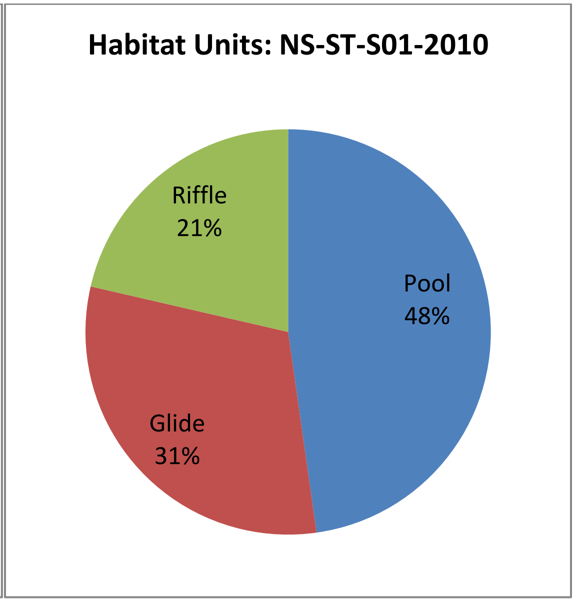
Substrate composition not recorded for this segment.



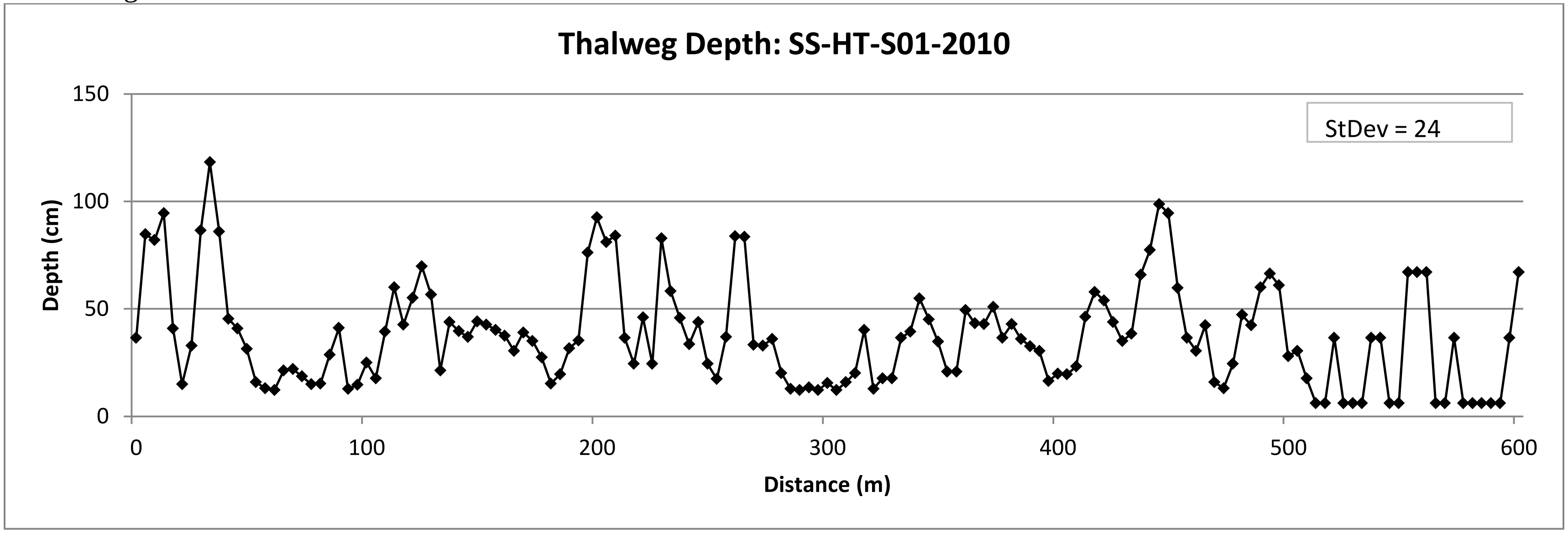
Stream Segment: NS-ST-S01-2010

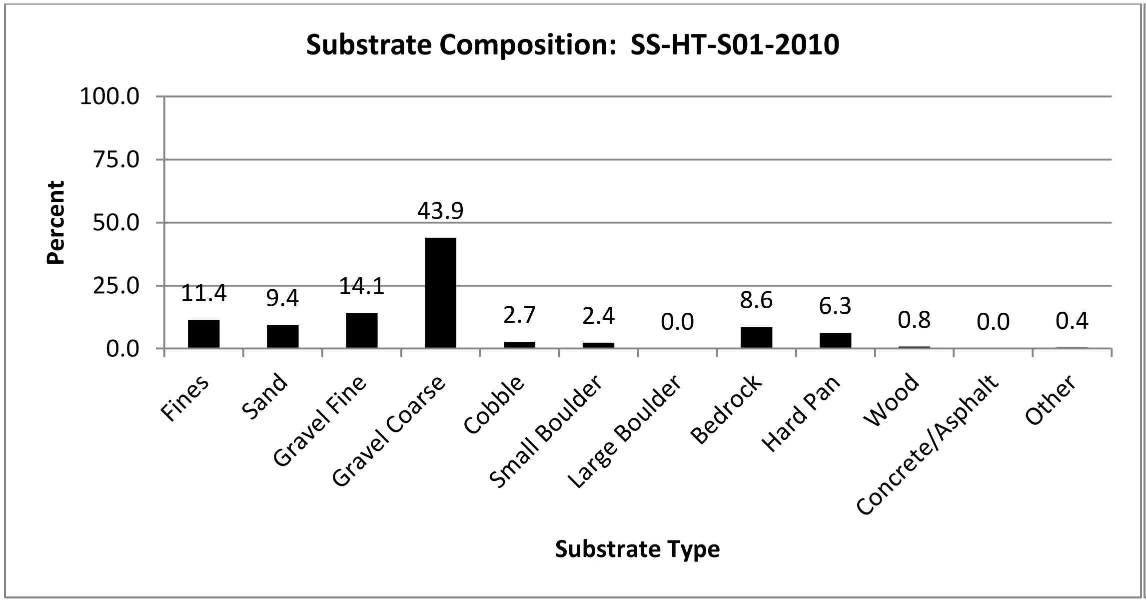


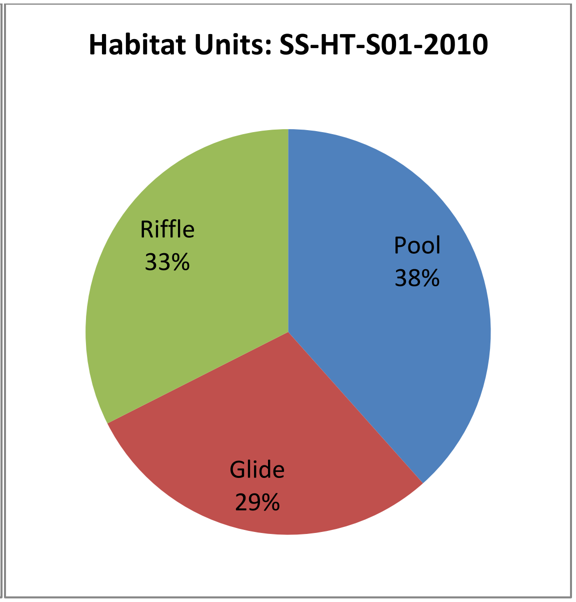




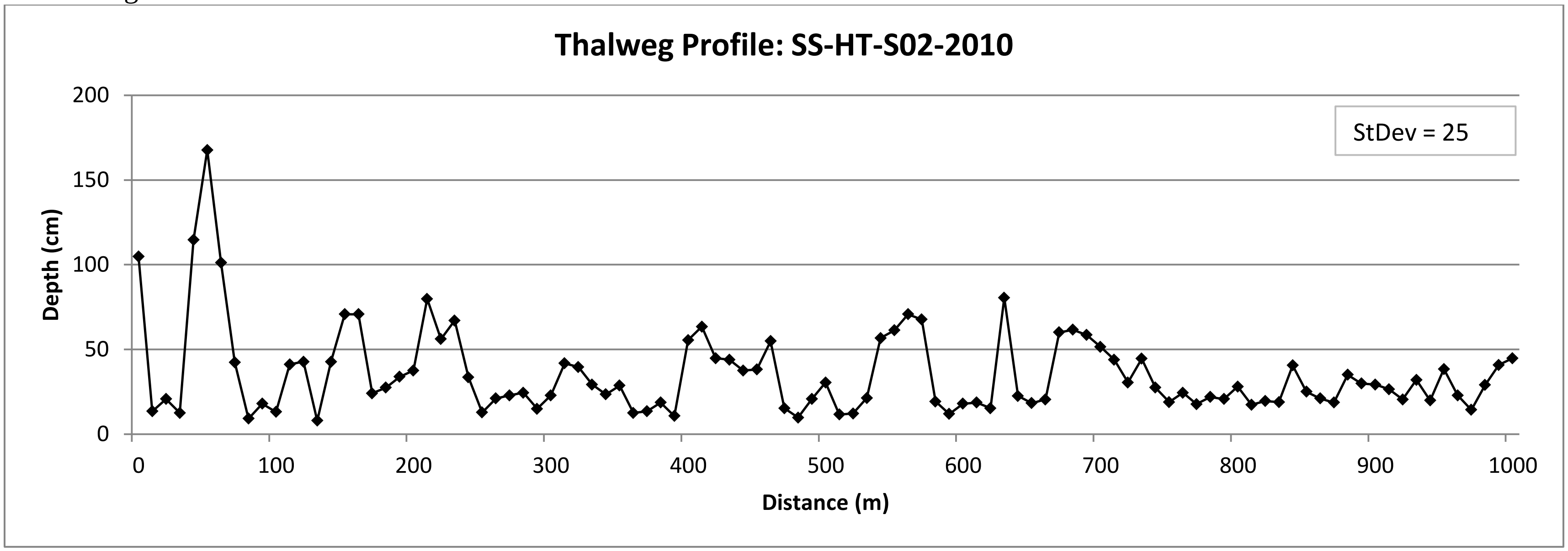
Stream Segment: SS-HT-S01-2010

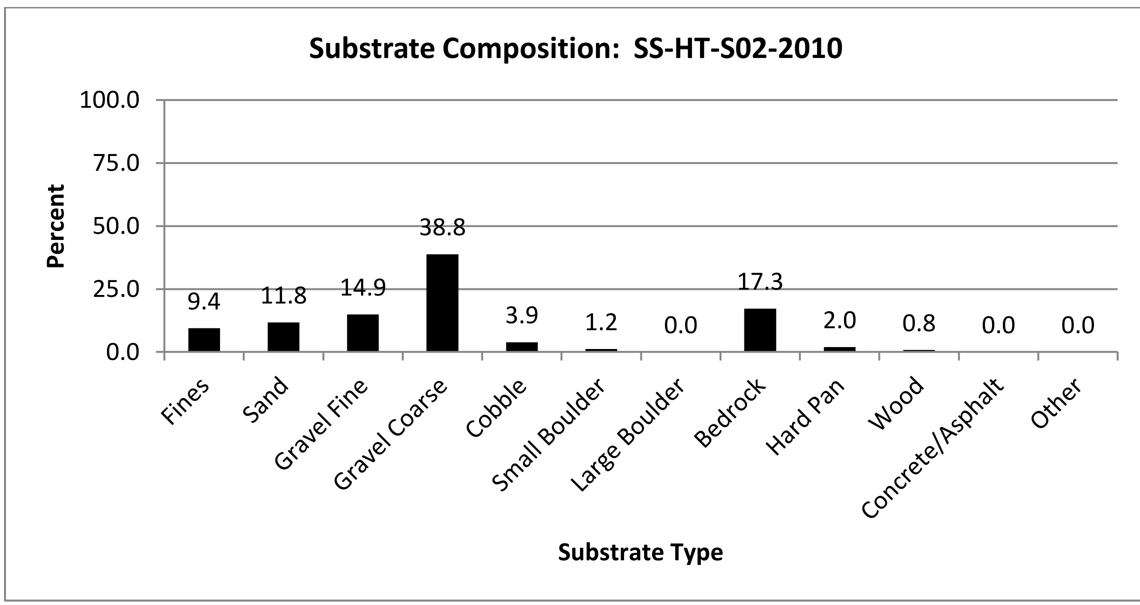


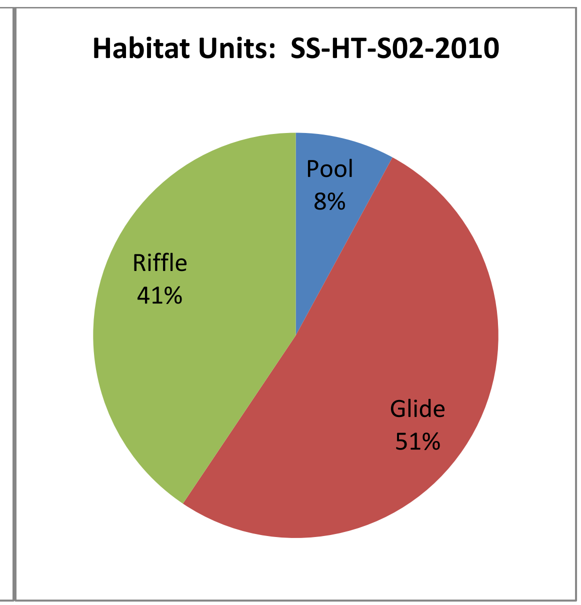




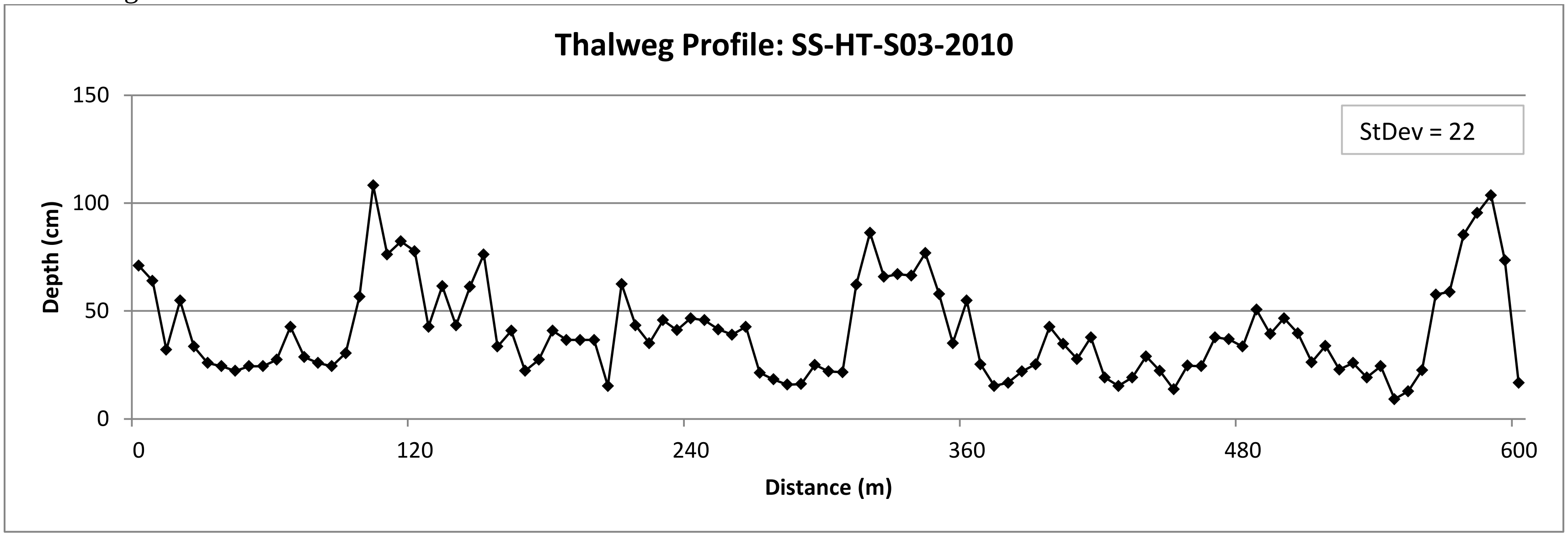
Stream Segment: SS-HT-S02-2010

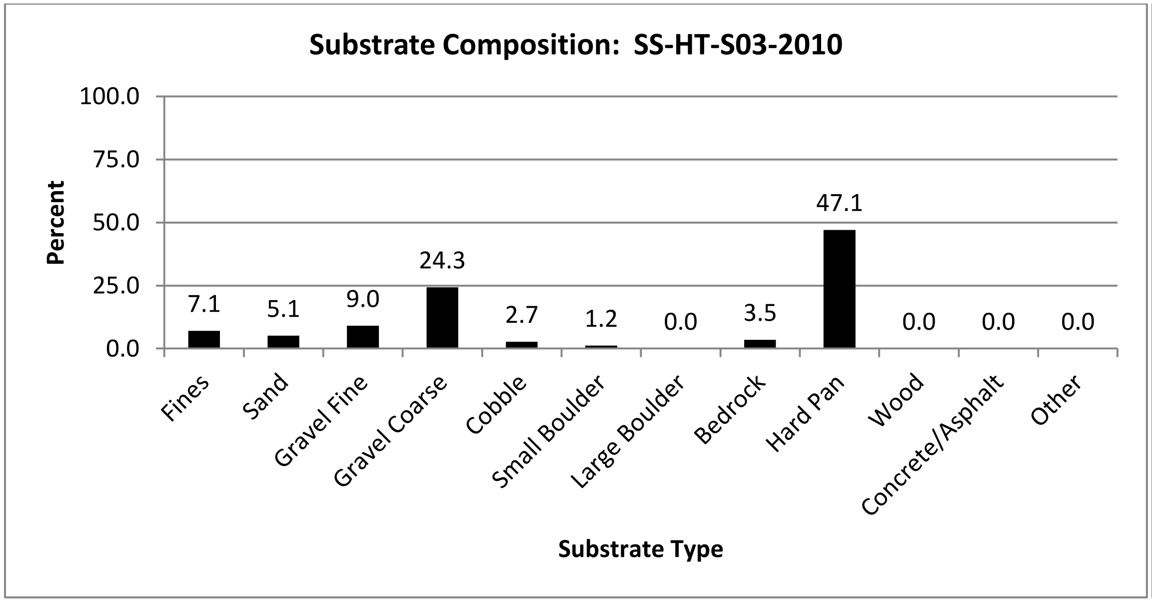


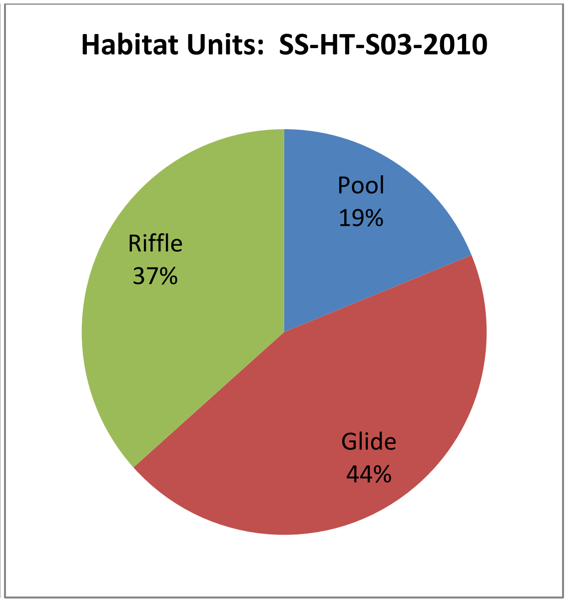




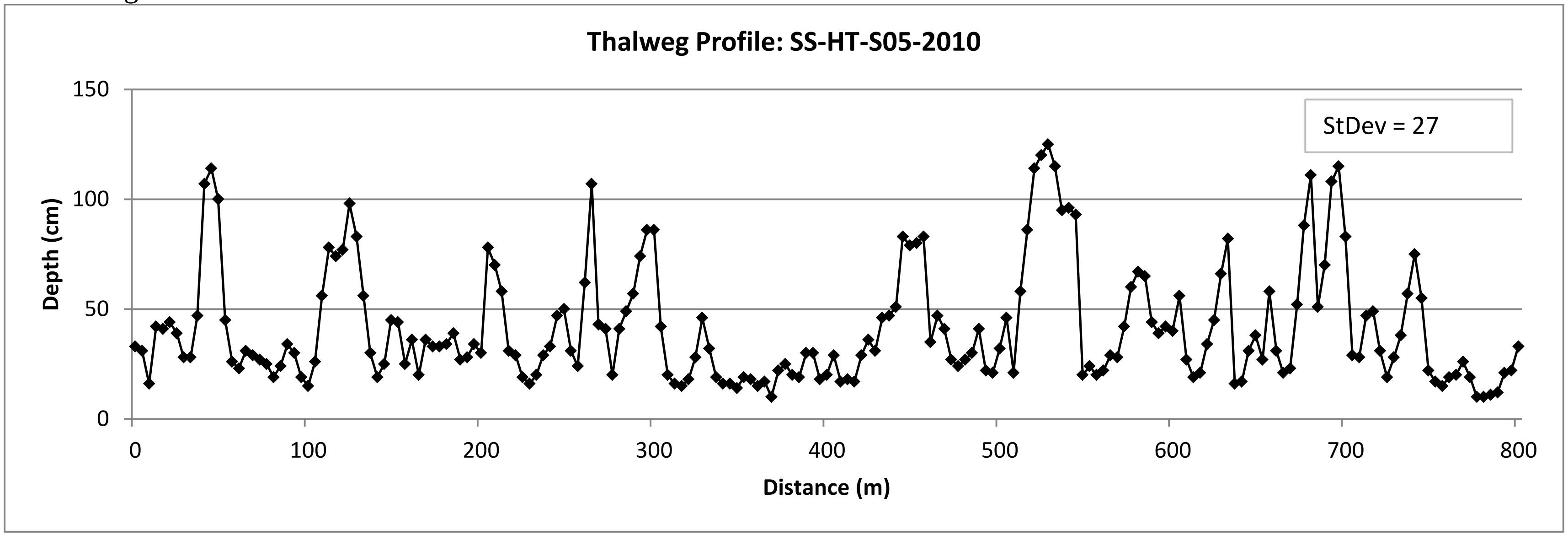
Stream Segment: SS-HT-S03-2010

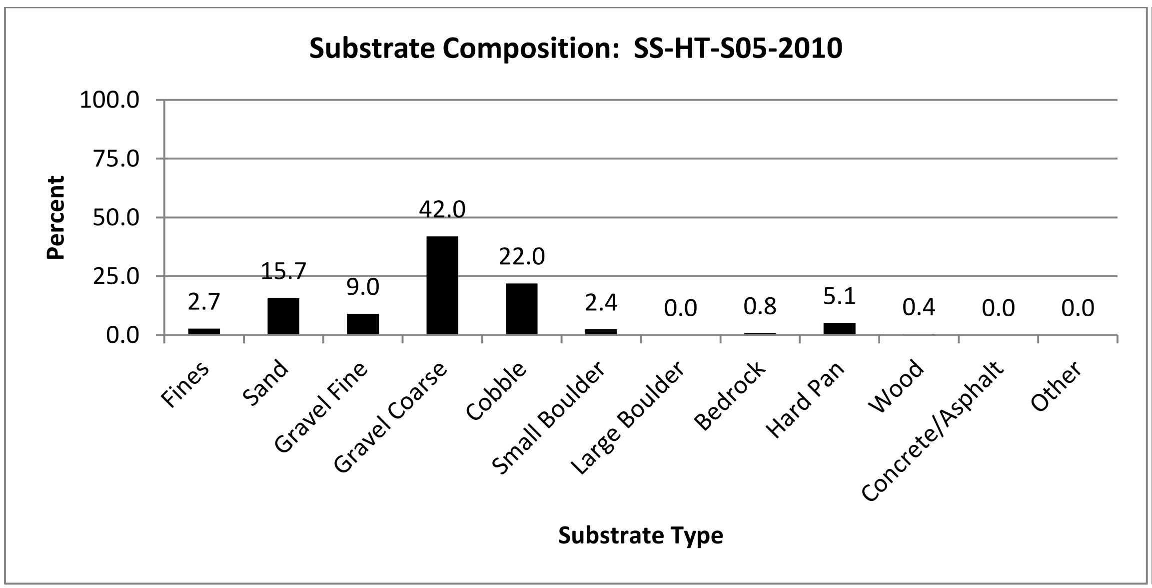


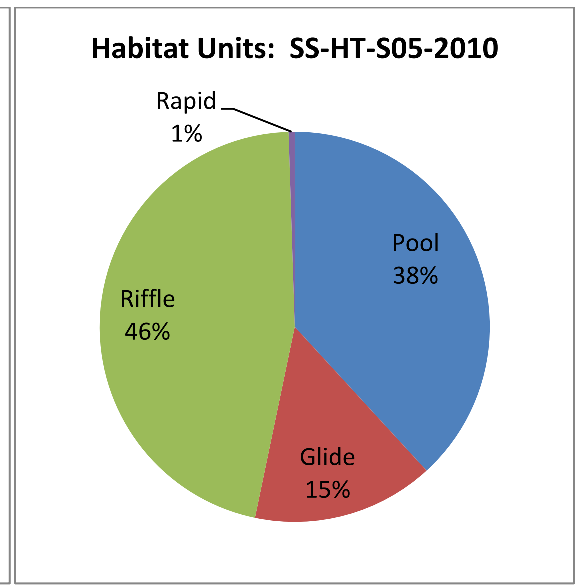




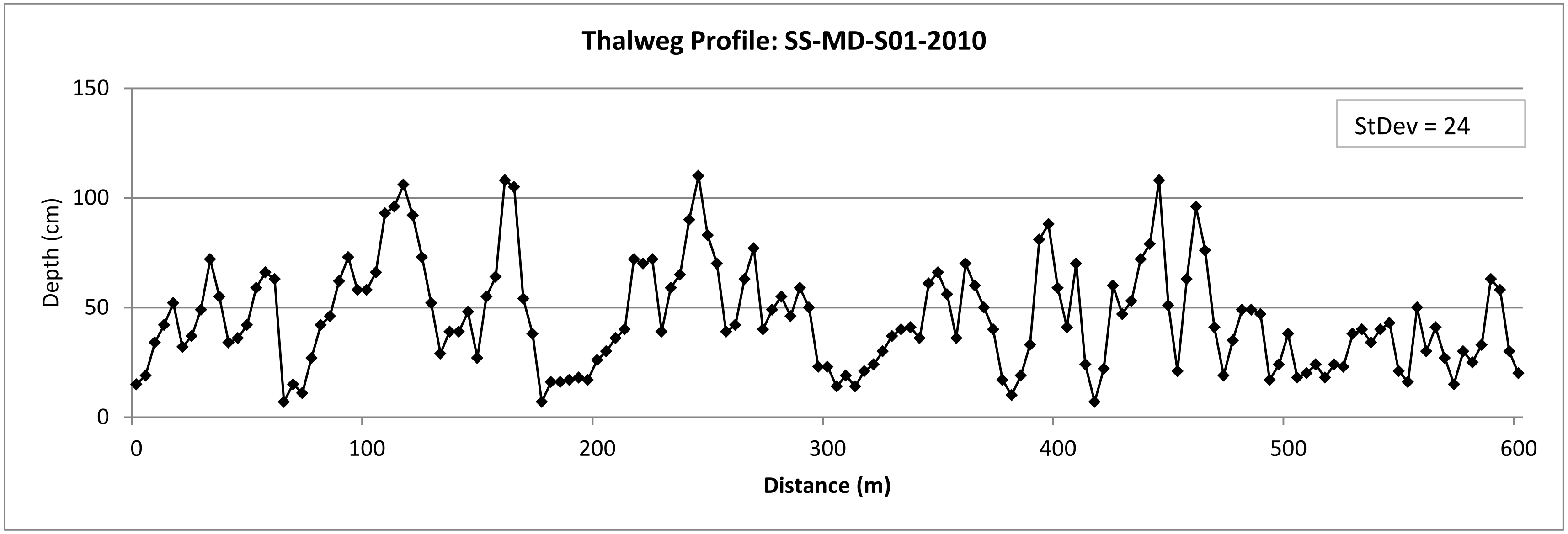
Stream Segment: SS-HT-S05-2010

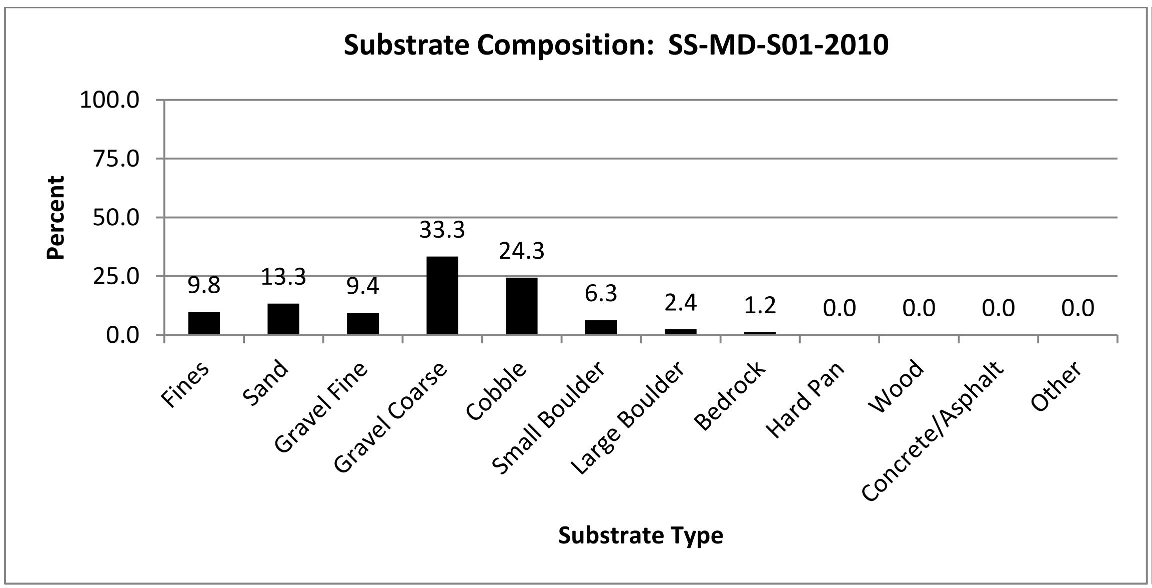


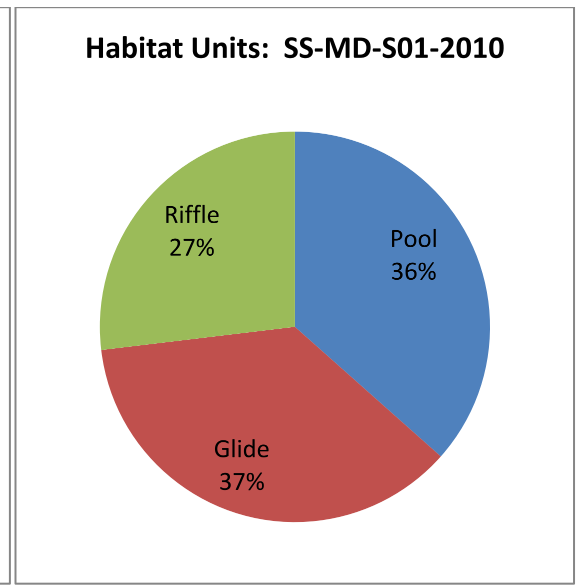




Stream Segment: SS-MD-S01-2010







Stream Segment: SS-MD-S03-2010