Status Report – Mason Brook and Mason Tributary

Tin Mountain Conservation Center

Trout Project

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14 August 2019

Glossary

Benthic macroinvertebrates: invertebrates that live in the substrate on bottoms of streams; not visible without the use of a handlense

Brook trout: freshwater fish belonging to the char genus Salvelinus of the salmon family Salmonidae; has red to pale colored spots surrounded by blue halos with a square shaped tail

Canopy: upper dense layer cover in the forest consisting of leaves and branches; provides shades to streams and understory

Flashy: a stream that is susceptible to high water events such as heavy rain; prone to flooding and quickly receding

Floodplain: areas along stream banks that historically flood during high water events; can act as a buffer for downstream watershed damage

Pool: slow-moving or lentic water, deep section of stream; generally inhabited by various fish species

Riffle: fast-moving lotic water in shallow sections of streams; typically characterized by protruding rocks and rapid-like appearance

Riparian zone: land and vegetation running along the terrestrial part of the stream including; trees, shrubs and herbaceous plants , etc.; crucial to stream function including; water quality, temperature regulation, flood control, bank stability and terrestrial and aquatic species survival needs

Watershed: cumulative land area draining into a particular stream; is part of a large stream order network

Woody material: trees and branches that are naturally or artificially added to streams

Introduction

Records suggest brook trout were more abundant in the past than they are today in New Hampshire (Noon, 2003). Logging history in the northeastern United States has resulted in channelized streams surrounded by young forests (Nugent & Carpenter, 2015).Streams characterized by long homogeneous riffle habitat and very few pools lacking gravel sites for spawning are associated with extensive logging histories (Nugent & Carpenter, 2015).With streams surrounded by old growth **riparian forests** large quantities of wood fall into the stream channel altering the flow, catching sediment and scouring deeper pools (Nugent & Carpenter, 2015). Although New Hampshire contains relatively intact habitat for brook trout, especially in the northern, White Mountains and higher elevation areas, their habitat is threatened by geomorphic and biological alterations, historic land use and runoff due to human impacts (Nugent & Carpenter, 2015). These past logging practices essentially removed the natural process of natural riparian wood additions into streams that create crucial habitat for eastern brook trout, *Salvelinus fontinalis,* so, consequences have been severe.

Mason Brook Tributary and Mason Brook were part of an effort to increase the amount of woody material in first-order streams throughout Carroll County. The addition of **woody material** simulates the natural process of riparian trees falling into first-order streams. The addition of woody material benefits water quality as well as habitat and cover for brook trout ranging from fingerlings to adults.

Wood additions improve water quality by trapping sediments and organic matter during high flow events in first and second order streams (USDA Natural Resource Conservation Service, n.d.). Without wood in streams to reduce velocity, organic material and sediments are deposited into larger streams, essentially affecting the amount of insects and invertebrates for brook trout (USDA Natural Resource Conservation Service, n.d.). Wood additions help reduce flood intensities by diverting the water into the **floodplain** significantly decreasing damage to the streambed and larger order streams. Not only do wood additions improve water quality and decrease stream damage, they play a value in improving brook trout habitat.

Over time, wood additions provide deeper pools and greater habitat diversity for brook trout during summer months and long winters (USDA Natural Resource Conservation Service, n.d.). Deeper pools provide brook trout with necessary water temperatures between 32 degrees Fahrenheit and 65 degrees Fahrenheit (Vermont Fish & Wildlife Department, 2019). Pools also provide water depth that act as a refugea for brook trout during summer droughts and cold winter months. Cascades and riffles form from the stream flowing over wood additions or natural logs, increasing oxygen content, gravel bars for spawning, and collecting organic material (USDA Natural Resources Conservation Service, n.d.). Not only do wood additions increase oxygen

content, spawning sites and organic material, it also plays and important role in providing habitat for **benthic macroinvertebrates**, a major food source for brook trout.

The project on Mason Brook first began in 2010 with a 1000-foot segment as the treatment site. In 2011, it was realized that Mason Brook Tributary had been treated in 2010 not Mason Brook, so 2011 was the year treatment began on Mason Brook with a 1000-foot segment. In 2016, an additional 3000-foot segment was treated on Mason Brook. Since there were three different years of treatment, Mason Brook 2010 is referred to as Mason Tributary and Mason 2011 and 2016 is referred to as Mason Brook.

Stream Assessment

Wood addition treatment was ideal for Mason Brook and Mason Tributary as it met several important criteria. NRCS stream requirements include having at least 1000-foot stretch of water with ownership on both sides of the stream. A habitat survey and wood survey were conducted on Mason Tributary and Mason Brook to assess characteristics as three separate projects conducted in 2010, 2011, and 2016. A **pool/riffle** map was generated for the entire stretch of all three reaches of the stream (Figure 1 & 2). A sample, pool/riffle combination, was randomly selected in each 100 foot section in all three separate projects to evaluate the habitat and conduct the wood survey.

Habitat

The habitat surveys assessed a number of geomorphic and hydrologic characteristics and the general conditions of the surrounding riparian zones. Riparian zones and **canopy** cover are both essential characteristics for quality brook trout habitat. An intact riparian zone is key to bank stability and acts as a pollution and runoff buffer for water quality and aquatic life (USDA, n.d.). Mature riparian zones are vital to future natural recruitment of natural wood additions into streams. Canopy cover comes into play by protecting the stream from direct sunlight through shade, in turn reducing stream temperatures (Bowler, Mant, Orr, Hannah & Pullin, 2012). Another significant role of canopy cover is the input of terrestrial invertebrates falling out of the canopy and into the stream providing food for brook trout.

Watershed

The Mason Brook watershed consists of 14.6 miles of stream habitat on 2,746 acres that flows into the Saco River. The Saco River is stocked by New Hampshire Fish and Game so, not all trout may be wild entering Mason Tributary and Mason Brook. This connectivity is important as Brook Trout travel into first and second order streams for spawning.

Methods

Mason Tributary and Mason Brook met the 1000-foot contiguous stream connection protocol, in turn grade-stakes were placed in 100-foot intervals along each section on Mason Tributary and on Mason Brook.

Mason Tributary

According to Green Mountain National Forest protocol in 2010, 52 pieces per mile or 36 pieces per 1000 ft is ideal for increasing Brook Trout habitat. The approach at the time for adding wood to Mason Tributary consisted of three to four pieces or structures of wood per 100-foot interval (Figure 3). A 1000-foot stretch on Mason Tributary in 2010 was measured to serve as the treatment site.

Mason Brook

In 2011, a 1000-foot stretch was measured on Mason Brook to serve as the treatment site (Figure 3). The 2011 section began where Mason Tributary flows into Mason Brook. In 2011, a six percent wood coverage goal was being used to increase Brook Trout habitat in the stream. In 2016, a 3000-foot stretch was added onto Mason Brook beginning at the 2011 Mason Brook 1000-foot marker (Figure 3).

Target Percent of Wood Coverage

Before adding wood to MasonTributary and Mason Brook a wood survey was conducted to calculate the amount of woody material existing in the stream. The wood survey indicates the percent of the stream course that was covered by woody material and its stability. According to John Magee of New Hampshire Fish and Game, old growth forests consisted of 15 percent wood percent coverage increasing Brook Trout habitat. Due to conserving, a goal of ten percent wood coverage was determined to be suitable. The wood additions consisted of standing or fallen trees on the property and were placed strategically in the stream. Orientations of the wood additions were based on intended function, for example, forming pools upstream and downstream or diverting water into the floodplain during high flow events. Longer additions were pinned against rocks or trees to hold the wood in place, increasing pool formation.

Riparian Forest Composition

Canopy cover provides temperature regulation to the stream supporting various aquatic and terrestrial species (USDA, n.d.). The canopy provides ample shade, however, to keep canopy cover percentage high the cutting of riparian trees were avoided during wood additions.

Stream Gradient

The stream gradient was calculated to measure the change in elevation from the beginning of the treatment site, stake zero, to the end of the treatment site for Mason Tributary and Mason Brook. Mason Tributary has a gradient of 2.5% and Mason Brook has a gradient of 3.5%. Although gradients above 2%, tend to be **'flashy'**, rising quickly with a lot of velocity, followed by water levels dropping quickly after a significant weather event, the stream has more of a steady flow moving large amounts of lightweight sand and gravel. Large amounts of substrate moving downstream could degrade spawning grounds, habitat and viable food sources that Brook Trout need, which wood additions could help control substrate movement.

Electrofishing

Electrofishing was a non-harmful, effective method of sampling fish. An electrical pulse is sent from the electroshocking unit and elicits a state of galvanotaxis, a fish's uncontrolled muscular convulsions that result in involuntary swimming towards the anode of the electrofisher (FishBio, 2017). This essentially expands the swim bladder, air sac, causing them to turn to their side and float to the top. Fish are then netted, placed into buckets where they are revived, identified, weighed and measured. Mason Tributary was treated with wood additions in 2010 and Mason Brook was treated with wood additions in 2011 and 2016. Electrofishing began in 2010 after wood additions on Mason Tributary and in 2011 and 2016 before wood additions on Mason Brook. Electrofishing started in the 2016 section of Mason Brook within the 3000-foot stretch from stake 0 to 150, 350 to 500, 850 to 1000, 1000 to 1150, 1350 to 1500, 1750 to 1900 and 2000 to 2150 equaling 1050 ft. Electrofishing did not occur in 2017.

Results

Mason Tributary

Habitat Survey

The average pool length was 13.65 ft while the average width was 8.3 ft. The average pool depth was 0.87 ft and cover provided from pool samples was 21%. The average pool canopy cover was 80%. The percent of stream in pool habitat was 14.7%. The average riffle length was 25.1 ft with the width averaging 7.38 ft. The average riffle depth was 0.64ft with a total riffle cover of 17%. Riffle canopy cover average was 80%. The bankfull width averaged 13.86 ft while the wetted width averaged 7.84 ft. Dominant substrate in the pool consisted of 40% sand and 60% gravel 1 (Figure 4). The riffle dominant substrate was 100% gravel 1 (Figure 5).

Wood Survey

The average percent of wood in pool habitat was 35.18% while on average the percent of wood in riffle habitat was 39.81% over the entire1000-foot segment. 84.21% of wood in pools stored sediment and 15.79% did not store sediment. 65.11% of wood in riffles stored sediment and 32.88% did not store sediment in riffle areas. 63.5% of wood in pools provided cover while 36.84% did not. 65.11% of wood in riffles provided cover while 34.88% did not provide cover in riffles. The average decay class of wood in decay class one, new wood, was 5.55%, decay class two was 3.70%, decay class three was 7.40%, decay class four was 29.62% and decay class five, old rotten wood, was 53.70%.

Wood Additions

17 pieces of wood were added to Mason Tributary. The diameter averaged 0.58 ft. Wood additions consisted of Eastern Hemlock, White Ash, American Beech, Red Maple and Sugar Maple. An additional 7 pieces were added on August 14, 2010.

Electrofishing

Between 2010 and 2018, 256 Brook Trout were captured along with 2 Slimy Sculpin, *Cottus cognatus*. A total of 43 Brook Trout were missed electrofishing. Brook Trout biomass (Figure 6) and density (Figure 7) were calculated from 2010 to 2018. The biomass in 2010 was 131.62 fish mass per sample area with a density of 14.76 fish mass oer sample area. The biomass in 2018 was 638.05 fish mass per sample area with a density of 85.58 fish mass per sample area. The average biomass of Brook Trout is 363.63 fish mass per sample area and the average density is 39.29 fish mass per sample area. The r-square value of Brook Trout biomass was 0.6285 while the density was 0.672.

Mason Brook 2011 Section

Habitat Survey

The average pool length was 8.33 ft and the average width was 7.03 ft. The pool depth was 1.05 ft on average and the cover provided from pool samples was 28.5%. The average pool canopy cover was 92%. The percent of stream in pool habitat was 8.87%. The average riffle length was 7.48 ft and the average width was 6.06 ft. The average riffle depth was 0.85 ft and the total riffle cover was 17.5%. The riffle canopy cover was 95%. The average bankfull width was 9.99 ft and while the wetted width averaged 6.545 ft. Dominant substrate in the pool consisted of 70% gravel 1 and 30% boulder (Figure 8). The riffle dominant substrate was 50% gravel 1, 20% wood and 30% boulder (Figure 9).

Wood Survey

The average percent of wood in pool habitat was 54.39% while the average percent of wood in riffle habitat was 45.61% within the 1000-foot section. 53.57% of wood in pools stored sediment and 46.43% of wood did not store sediment in pools. 54.17% of wood in riffles did store sediment while 45.83% of wood in riffles did not store sediment. 78.57% of wood in pool areas provided cover while 21.43% did not. Wood in riffle areas provided 70.83% of cover while 29.17% of wood did not provide cover in riffles. The average decay class consisted of decay class one, new wood, being 2.04%, decay class two being 0%, decay class three being 14.29%, decay class four being 51.02% and decay class five, old rotten wood, being 16.33%.

Wood Additions

There was 613.97 square feet of wood existing in Mason Brook with a total wood percentage of 6.15%. 15 pieces of wood were added to Mason Brook totaling 220 square feet bringing the wood percent coverage up to eight percent. The average length of the wood added was 26.15 ft with an average diameter of 0.52 ft. Wood additions consisted of Eastern Hemlock, Yellow Birch, Red Maple and American Beech.

Electrofishing

From the year of 2011 to 2016 a total of 455 Brook Trout were caught along with 28 Slimy Sculpin. A total of 47 Brook Trout were missed. Brook Trout biomass (Figure 10) and density (Figure 11) were calculated from 2011 to 2018 . The biomass of Brook Trout in 2011 was 539.75 fish mass per sample area while the density was 69.07 fish mass per sample area. The biomass in 2018 was 1230.65 fish mass per sample area and the density was 169.39 fish mass per sample area for Brook Trout. The average biomass of Brook Trout is 785.06 fish mass per sample area and the average density is 106.89 fish mass per sample area. The r-square value for biomass is 0.6909 while the density is 0.7431 for Brook Trout.

Mason Brook 2016 Section

Habitat Survey

The average pool length was 10.13 ft and the width averaged 6.21 ft. Pool depth averaged 1.05 ft and the cover provided from pool samples was 33%. The average pool canopy cover was 95%. The percent of stream in pool habitat was 11.77%. Riffle length averaged 14.17 ft and the width was 5.25 ft. The average riffle depth was 0.52 ft and the total riffle coverage was 45.91%. The riffle canopy cover averaged 80%. The average bankfull width came out to 8.61 ft while the average wetted width was 6.06 ft. The dominant substrate in pools was 70% sand, 20% gravel 1,

30% gravel 2 and 10% cobble (Figure 12). The riffle dominant substrate was 70% sand, 25% gravel 1, 15% gravel 2, 20% cobble, and 10% wood (Figure 13).

Wood Survey

The average amount of wood pool habitat was 34.7% while the average wood riffle habitat was 65.3%. 68% of wood in pools helped stored sediment and 32% of wood in pools did not. 59% of wood stored sediment in riffles while 41% of wood in riffles did not store sediment. 48% of wood in pools provided cover and 52% of wood pools did not provide cover. 51% of wood within riffles provided cover while 49% of wood in riffles did not provide cover. The average decay class consisted of decay class one, new wood, at 10.4%, decay class two at 5.7%, decay class three at 20.8%, decay class four at 42.2% and decay class five, old rotten wood, at 24.1%.

Wood Additions

In 2016, 108 pieces of wood was added to Mason Brook equaling 1152.65 square feet of wood that was added to the stream. These wood additions added 4.41% to the stream bringing the total wood percent coverage to 12.8%. The average length of the wood was 17.7 ft with an average diameter of 0.6 ft. 64 pieces of wood were added below the bridge spanning 1750 linear feet. consisting of Eastern Hemlock, White Ash, American Beech, Red Maple, Sugar Maple, Red Oak, White Birch and Yellow Birch. 44 pieces of wood were added above the bridge spanning 1250 linear feet consisting of Eastern Hemlock, White Birch, White Ash, American Beech, Red Maple, Sugar Maple, Red Oak, and Yellow Birch.

Electrofishing

Electrofishing took place in 2016 and 2018 adding up to 423 Brook Trout being captured and 13 being missed overall. In 2016 the biomass was 3120.46 fish mass per sample area and the density was 449.38 fish mass per sample area. In 2018 the biomass of Brook Trout was 2184.04 fish mass per sample area and the density was 301.95 fish mass per sample area. The average biomass is 2652.25 fish mass per sample area and the density is 375.67 fish mass per sample area.

Conclusion

Based on habitat surveys, wood surveys and electrofishing data, the wood additions on Mason Brook Tributary and Mason Brook should improve Brook Trout habitat. Most of the wood additions that were manually cut by hand appear to have created larger, deeper pools with cover from direct sunlight. The specifically oriented wood additions should reactivate the floodplain during high flow events and decrease the velocity of the stream. Based on visual

observations, the wood additions have retained sediment and organics potentially increasing the amount of food for Benthic Macroinvertebrates, more food for trout.

Mason Brook Tributary

The dominant substrate in the pool and riffle areas consisted of high amounts of gravel 1 and sand. Although sand is not ideal spawning grounds for Brook Trout, an ample amount of gravel 1 was found on the streambed. Even though there are high amounts of gravel 1, suitable spawning grounds, the wood additions should retain sediment in pools and riffles, possibly increasing potential spawning grounds for Brook Trout. A majority of the existing wood provided ample cover for trout; however, this should increase with the addition of more wood in Mason Brook Tributary. The biomass and density of Brook Trout from 2010 to 2018 have slowly been increasing. With r-squared values of 0.6285 and 0.672, there may be a correlation between the increase in pool habitat and wood additions that support larger quantities of trout supported by the increase in biomass and density seen over seven years.

Mason Brook

The dominant substrate in the Mason Brook 2011 section supports ample spawning habitat for Brook Trout with pool areas consisting of 70% gravel 1 and riffle areas with 50% gravel 1. The 2016 section of Mason Brook consisted of mostly sand in pool and riffle areas which is not ideal spawning habitat. The wood additions may help increase the amount of spawning grounds in riffle areas by collecting sediment that Brook Trout can use. Existing pools and riffles showed high potential of supporting healthy Brook Trout because of ample cover, however, half of the pools and riffles present did not provide cover, so adding wood increase coverage in pools and riffles. By visual observation, the wood additions have increased cover by providing ample shaded areas from sunlight and predation. Sediment storage has also increased according to observations by forming larger sand bars on the sides or middle of the stream. Between 2011 and 2018 the biomass and density of Brook Trout in the 2011 section of Mason Brook has been slowly increasing. With r-squared values of 0.6909 and 0.7431 there could be a connection with an increase in trout biomass and density due to wood additions. Since Mason Brook had less gravel streambed than Mason Brook Tributary the density of trout could be higher due to wood additions trapping sediment, increasing spawning grounds for Brook Trout. In the 2016 section of Mason Brook there is a slight decrease in trout biomass and density. Since this section of Mason Brook received wood additions only a few years ago it is unknown when or if there will be an increase biomass and density. Based on data analysis on the 2011 section of Mason Brook, there should be an increase in trout biomass and density in the 2016 section in future years.

With the addition of wood in Mason Brook Tributary and Mason Brook the wood additions should create larger, deeper pools helping to create cascades and small falls increasing

oxygen content, pool habitat, Benthic Macroinvertebrates and spawning grounds for Brook Trout. Although Mason Brook Tributary and Mason Brook have ample spawning substrate for trout, the wood additions should help create more areas in pools and riffles suitable for spawning, essentially increasing Brook Trout biomass and density. Even though the biomass and density of Brook Trout is slowly increasing in Mason Brook Tributary and in the 2011 section of Mason Brook, continued electrofishing will help analyze the biomass and density of Brook Trout compared to the benefits of wood additions.

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Figures

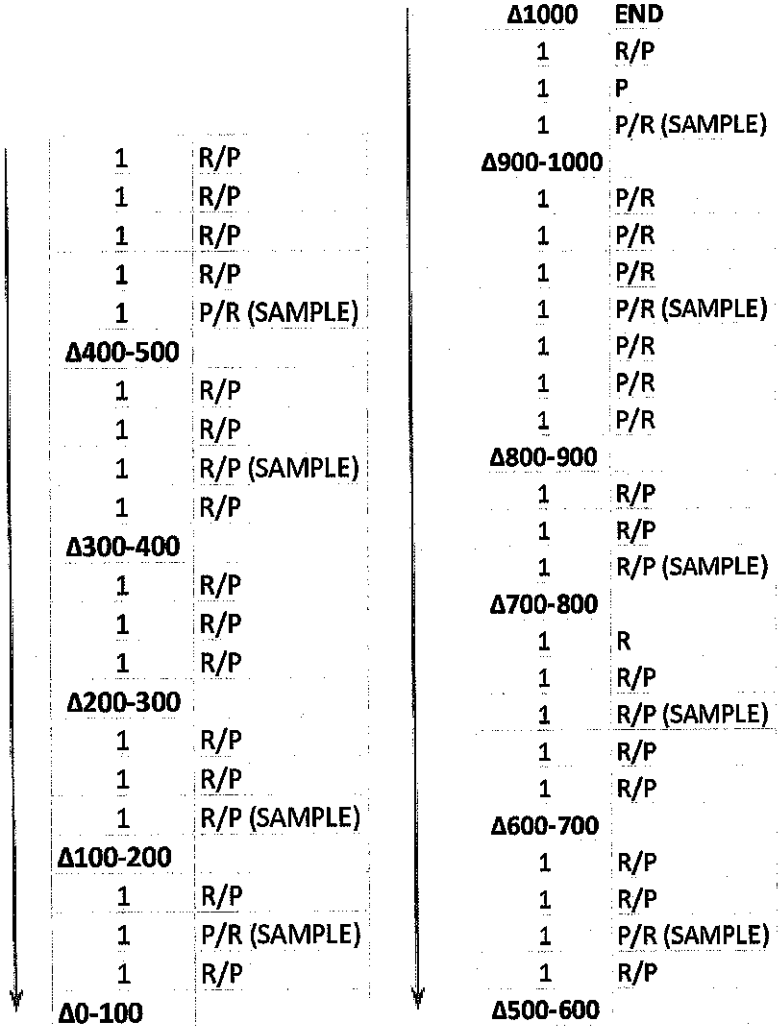

Figure 1: Mason Brook Tributary pool/riffle combination map of 1000 ft segment. The arrows, blue, show the direction stream flows. The numbers, with the triangle, represent the stake number and what habitat is between them. The map contains each pool and riffle and which one was randomly sampled for the habitat survey.

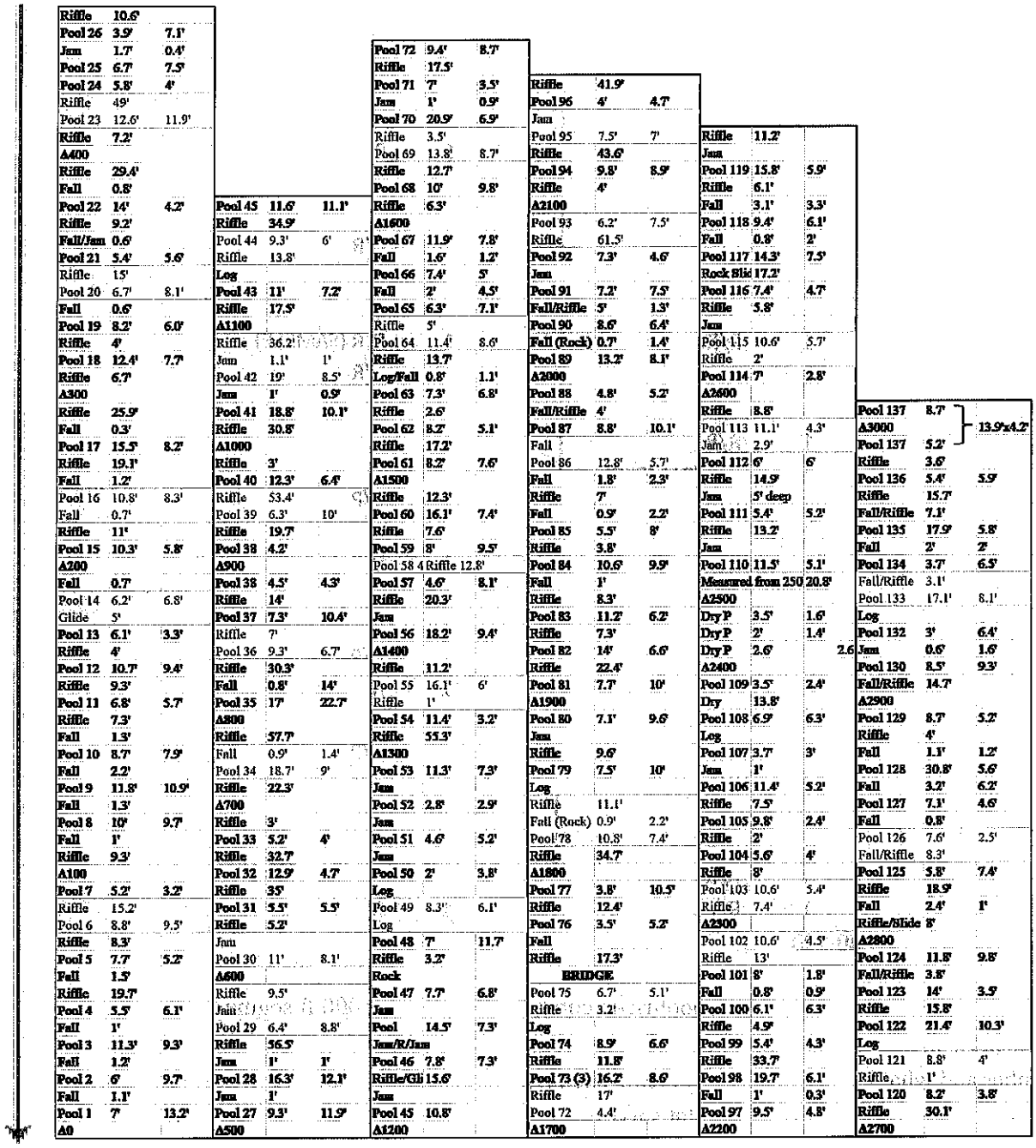

Figure 2: Mason Brook 2016 Section pool/riffle habitat map of 3000 ft segment. The arrow, blue, represents stream flow direction. The numbers, with triangles, represent the stake number and what type of habitat is between them. The map contains each pool, riffle, fall and jam. Each pool riffle sample, highlighted in yellow, was conducted in each 100 ft segment except for 2400 and 2500 as the stream was dry.

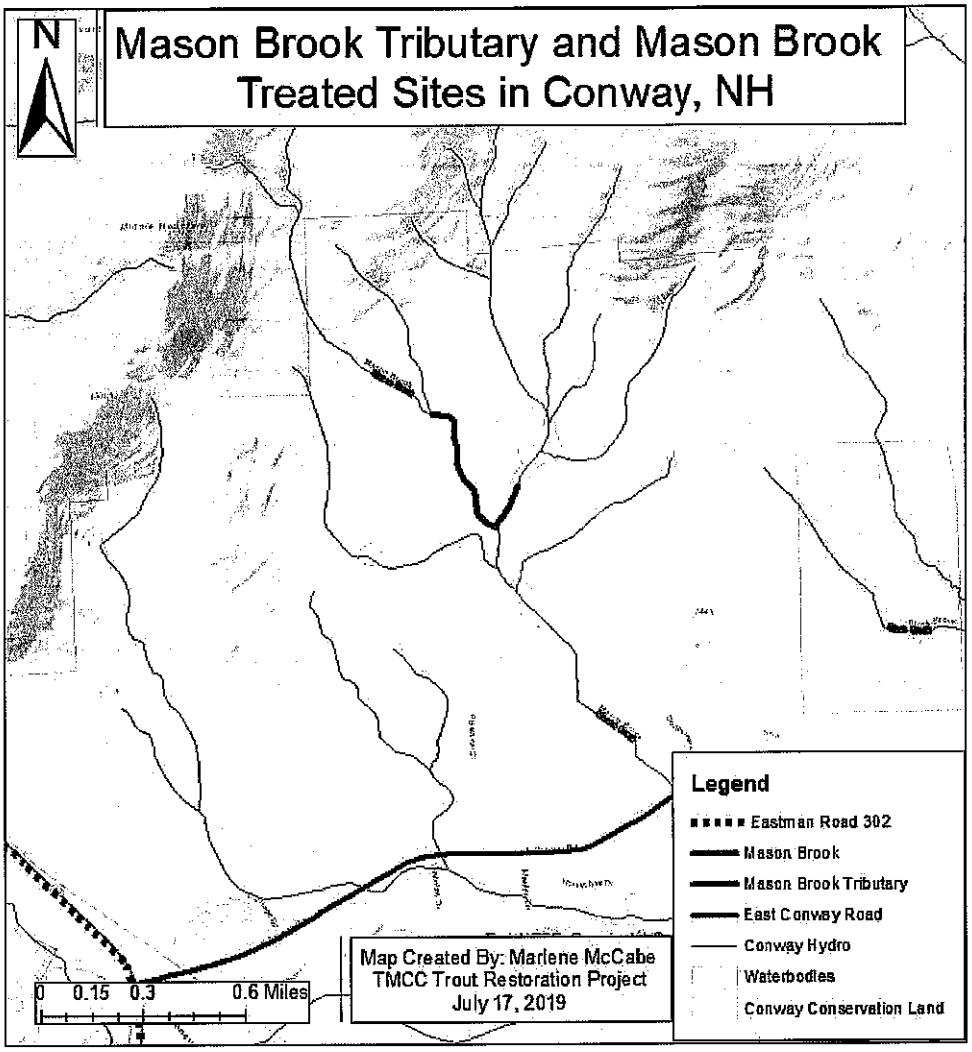

Figure 3: Treated wood addition sites on Mason Tributary and Mason Brook. The start of the treatment site for Mason Tributary begins downstream, 100 ft, of where it meets Mason Brook. The end treatment sit of Mason Tributary is where the wetland lies. The Mason Brook treatment site begins where it meets Mason Tributary and goes upstream a total of 4000 ft; 1000 ft in the 2011 section and 3000 ft in the 2016 section.

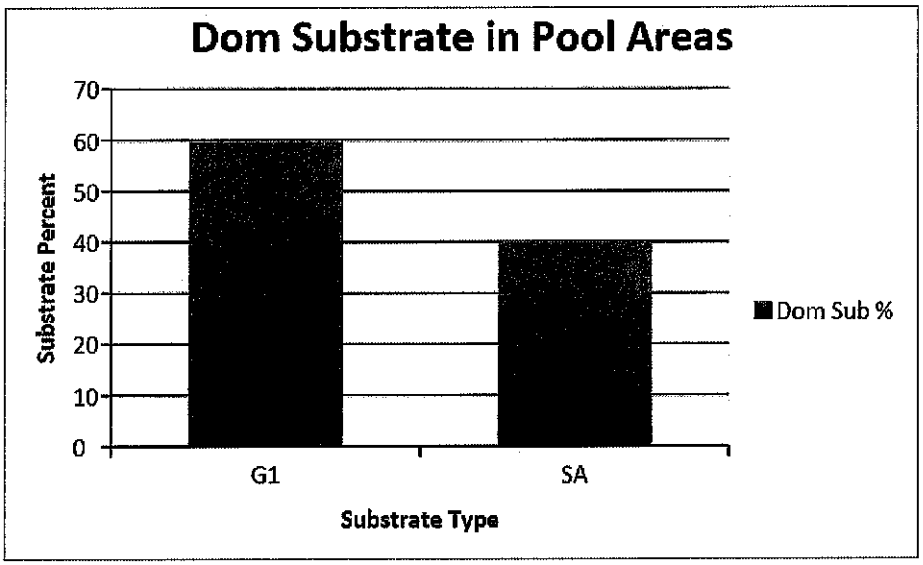

Figure 4: Dominant substrate percent in pool areas in Mason Brook Tributary. The substrate documented during the habitat survey in 2010 consists of two different grades; Sand and Gravel 1.

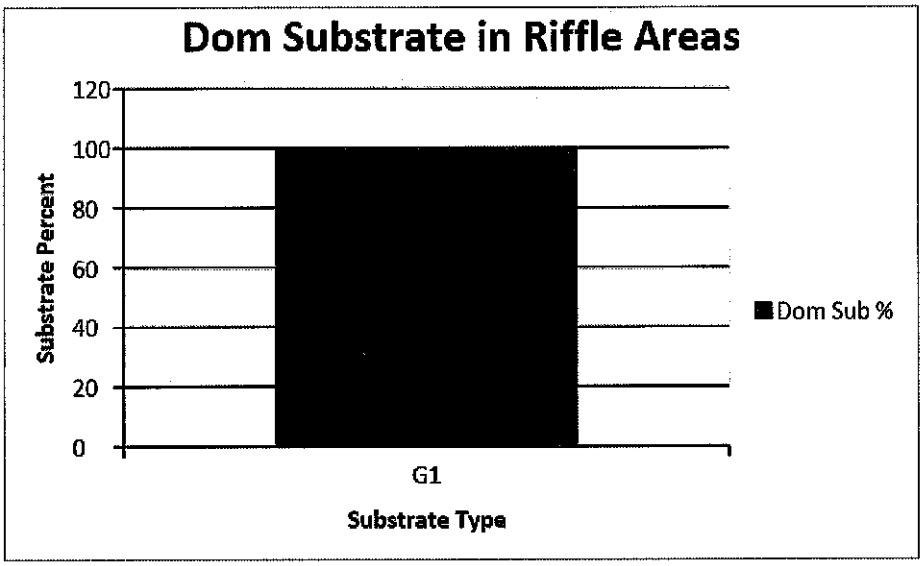

Figure 5: Dominant substrate in riffle areas in Mason Brook Tributary. The substrate documented during the habitat survey in 2010 consists of one grade; Gravel 1.

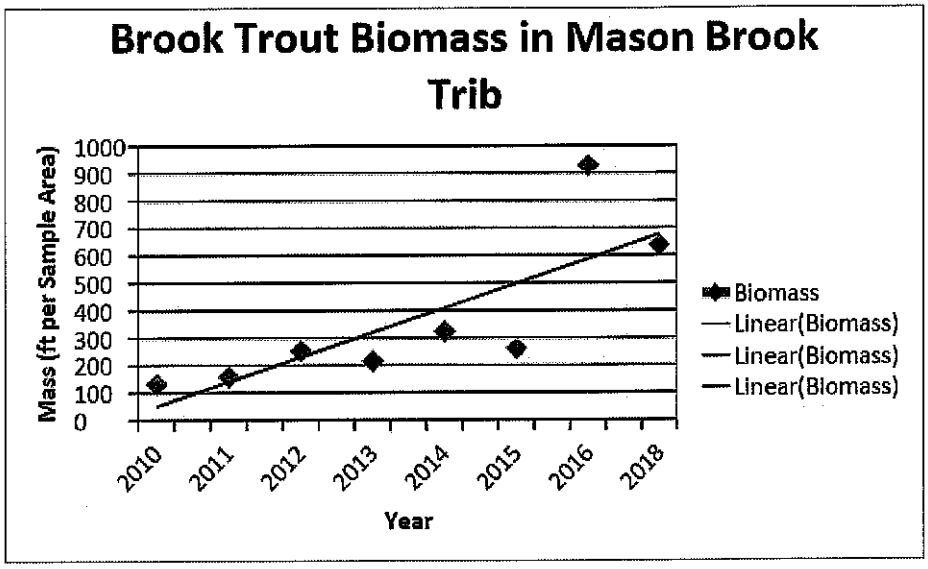

Figure 6: Brook Trout biomass in Mason Brook Tributary from 2010 to 2018. The average biomass of Brook Trout in Mason Brook Tributary is 363.63 ft per Sample Area. The r-squared value represents significance of mass compared to the year after wood additions.

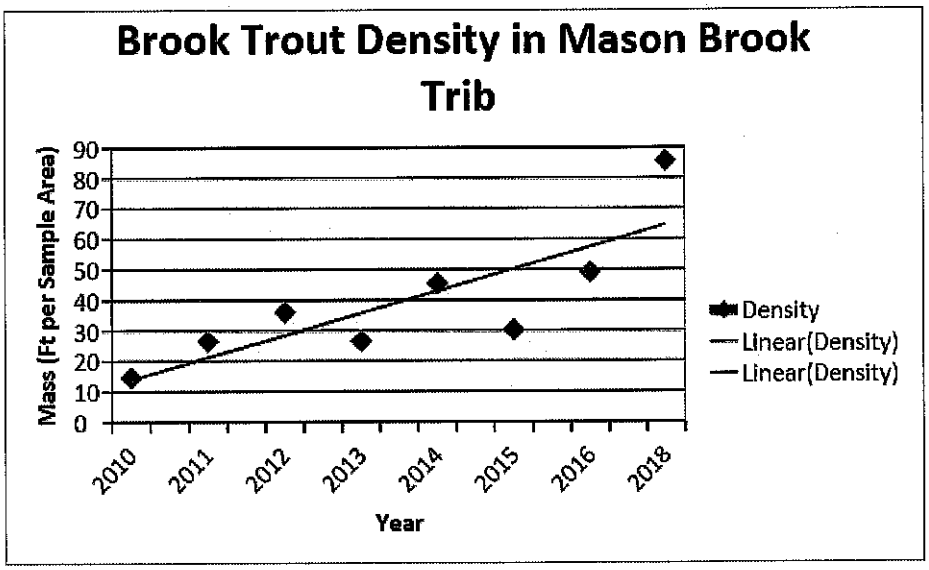

Figure 7: Brook Trout density in Mason Brook Tributary from 2010 to 2018. The average density of Brook Trout is 39.29 ft per Sample Area. The r-squared value represents the significance of mass compared to the year after wood additions.

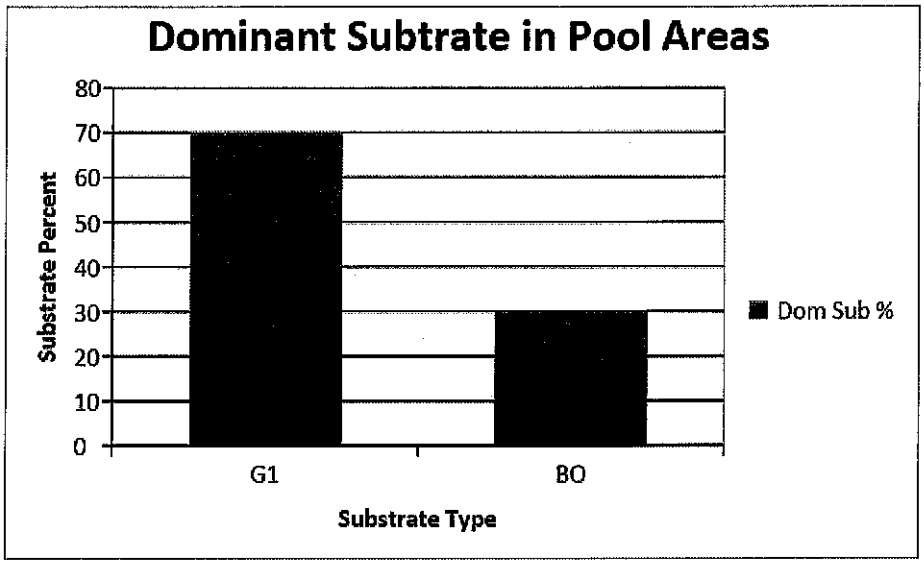

Figure 8: Dominant substrate percent in pool areas in the 2011 section of Mason Brook. The substrate documented during the habitat survey in consists of two grades; Gravel 1 and Boulder.

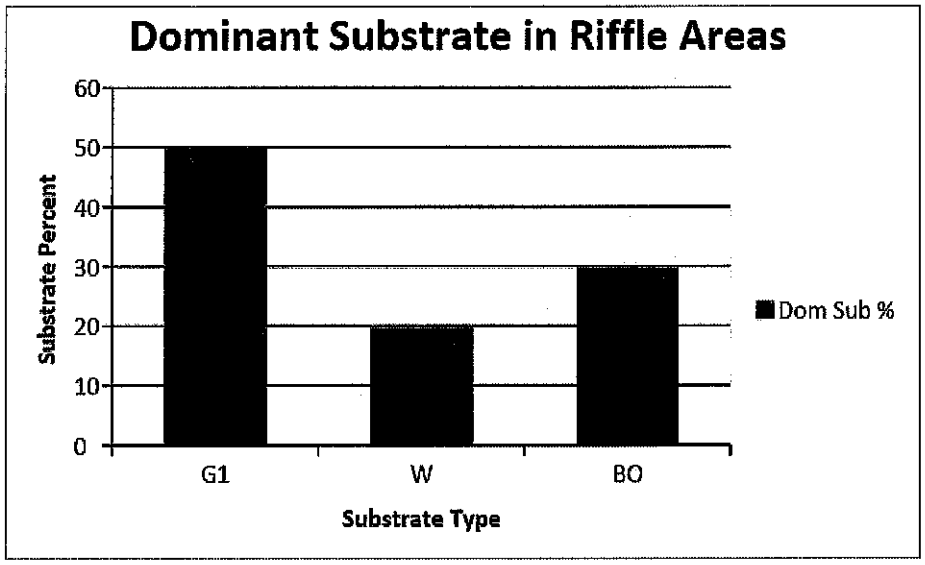

Figure 9: Dominant substrate percent in riffle areas in the 2011 section of Mason Brook. The substrate documented during the habitat survey consists of three grades; Gravel 1, Wood and Boulder.

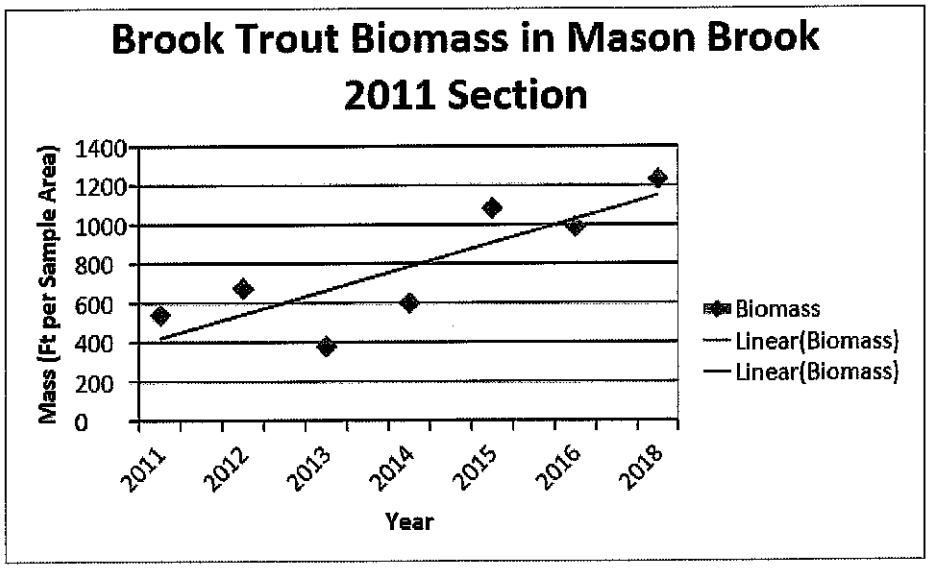

Figure 10: Brook Trout biomass in the 2011 section of Mason Brook from 2011 to 2018. The average biomass for Brook Trout is 785.06 ft per Sample Area. The r-squared value represents significance of mass compared to the year after wood additions.

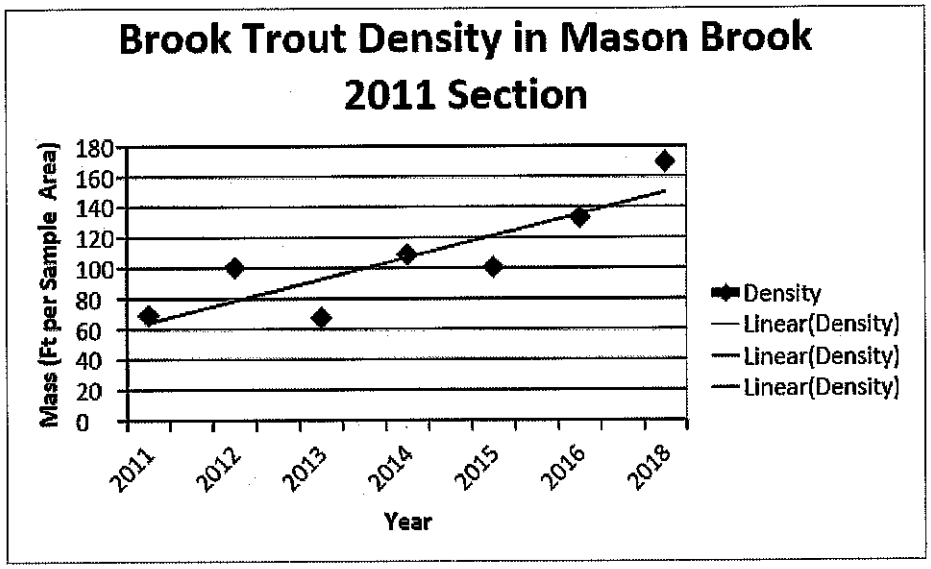

Figure 11: Brook Trout density in the 2011 section of Mason Brook from 2011 to 2018. The average density for Brook Trout is 106.89 ft per Sample Area. The r-squared value represents the significance of mass compared to year.

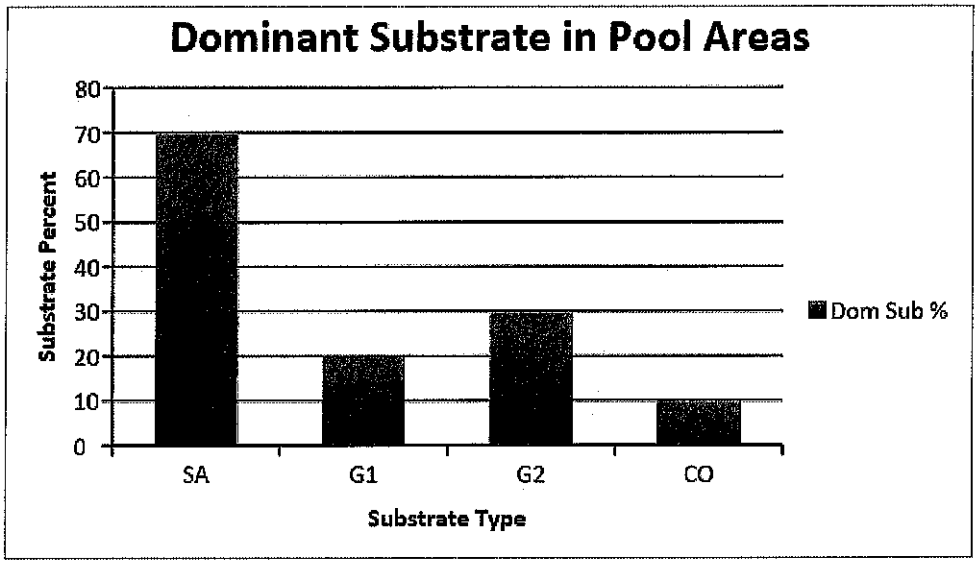

Figure 12: Dominant substrate percent in pool areas in the 2016 section of Mason Brook. The substrate documented during the habitat survey consists of four different grades; Sand, Gravel 1, Gravel 2 and Cobble.

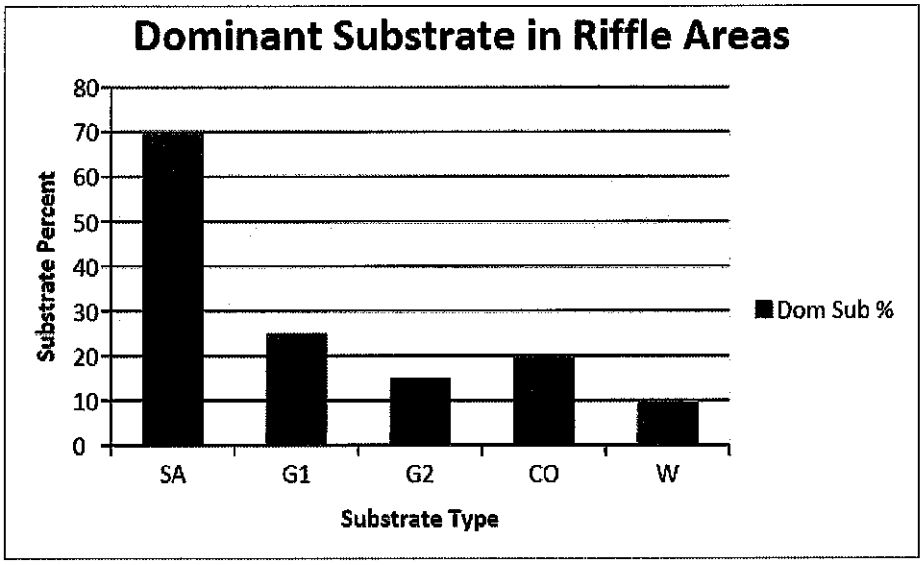

Figure 13: Dominant substrate percent in riffle areas in the 2016 section of Mason Brook. The substrate documented during the habitat survey consists of five different grades; Sand, Gravel 1, Gravel 2, Cobble and Wood.

Table 1: Substrate class depending on size ranging in inches. The sizing includes seven common substrates found in stream, rivers and or lakes and ponds.

Substrate Size Class		
SA	Silt/Sand	< 1/4 in
G 1	Small Gravel	1/4-3 in
G 2	Large Gravel	3.1-6.0 in
C O	Cobble	6.1-12 in
B O	Boulder	> 12 in
BR	Bedrock	large solid mass
O R	Wood	wood/ Her