Cambridge Secondary 2

Cambridge IGCSE

Coursework Exemplar 1

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Geography **0460**

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Individual Record Card

		Skills and analysis				
Titles or Subjects of Assignment & Curriculum Themes	Knowledge with understanding	Observation and Collection	Organisation and Presentation	Analysis	Conclusion and Evaluation	Total
An investigation into the downstream changes of a river (Nubanusit).	12 (max 12)	11 (max 12)	11 (max 12)	11 (max 12)	11 (max 12)	56 (max 60)
* Indicates mark to be transferred to Coursework Assessment Summary Form			Amount of Scaling (if relevant)	0	Internally Moderated Mark	56 (max 60)

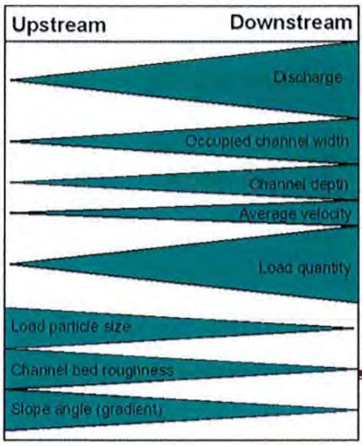
An investigation into the downstream changes of a river (Nubanusit)

Contents

Introduction

The river which our Geography class is going to visit is located in New Hampshire in Peterborough, about two hours away from Boston. We are going to be looking at the Nubanusit River, also referred to as the 'Busy Brook', at Sargents Centre. This location was chosen because; it is close by and very accessible with accommodations and equipment needed for necessary data collection. The location is in a rural area so the river will be safe unlike fast flowing rivers high up in the mountains or a river flowing through various states such as the Charles River. The river will also be easy to get to as it is located by a road (as shown in the images below.)

While we are at the river we will be looking at various sites along it and recording data to see how a river changes downstream. An example of some of the data which we shall be recording at twenty sites will be width, depth, velocity, sediment size, roundness, sphericity etc. We will be collecting this data on the 3rd and 4th of May which is a good month because all the snow has gone therefore the river will be flowing; and not dried up as it would in intense heat. Our geography class chose rivers for our coursework because, they are very accessible, common and data can be collected in a short period of time. Rivers is also part of our IGCSE curriculum so as we have been studying them it seemed a very appropriate topic.



Bradshaw Model

To the left is a diagram of the Bradshaw model. The Bradshaw model is a geographical model describing how characteristics in a river will vary and change between the upper course and lower course of the river. The model shows that as a river goes downstream the discharge, occupied channel width, depth of channel, average velocity and load quantity will increase. Whereas load particle size, channel bed roughness and slope angle will decrease as it flows downstream.

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The reason for increase and decrease in characteristics links to erosion, transportation and deposition of sediment. The four types of erosion are:

1. Attrition - this occurs as rocks bang against each other gradually breaking each other down.

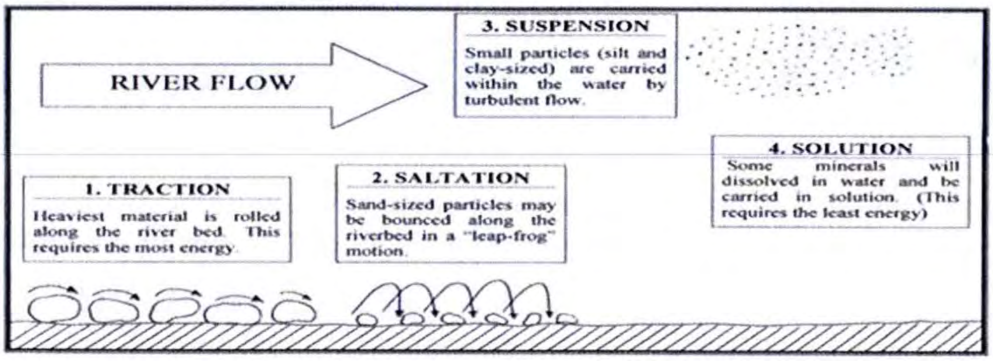
2. Abrasion - this is the scraping away of the bed and banks of the river by material transported in it.

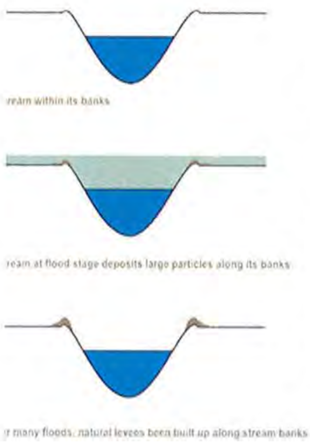
3. Solution - the chemicals in the river dissolve minerals in the rocks, bed and bank carrying them away in solution.

4. Hydraulic Action - this is when the water in the river compresses the air in cracks of the bed and banks. This results in increased pressure caused by the compression of air gradually forcing apart parts of the bed and banks.

Along with erosion there are four types of transportation which cause the rivers characteristics to fluctuate along the river:

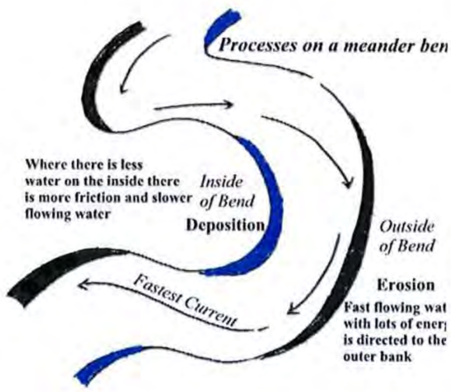
River Processes: Transportation





Deposition

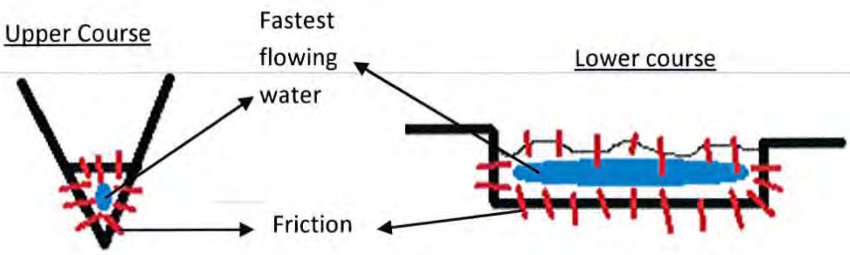
Deposition is where material is carried by the river and then dropped. This occurs when there is no longer a sufficient amount of energy to keep transporting the sediment. Deposition can be found on meanders (shown by the diagram on the right) and creates levees (as shown by the diagram on the left). It prevents flooding: and of course makes up the floodplain itself.



Predictions

By using the Bradshaw model and my own knowledge about rivers I predict that:

- The width will increase- as you get downstream the river links to more tributaries causing more water to join with the main river therefore increased erosion.
- The channel depth will increase- due to erosion and transportation. Abrasion will create a deeper channel bed making it smoother as it constantly gets rubbed by sediment. Also as the heaviest rocks are rolled along the river bed, traction will break it down.
- Particle size will decrease downstream – as rocks and sediment head downstream they will be bumping and hitting each other more often and consequently breaking down by the act of attrition.
- Sediment shape will change- at the top of a river the rocks will be very jagged because they are at the source and haven't been acting against any other sediment. As the sediment is transported downstream it will be banged into the river bed and other material, therefore becoming smoother and smaller.
- Velocity will increase-



The diagrams above show how velocity increases downstream. The red lines represent the friction, the blue represents the water and the black is the river bed and sides. As you can see above there is more friction present upstream. This happens because there is a smaller cross section of water. Downstream there is more water that isn't affected by friction and so the faster flow may be deeper. Furthermore, in some rivers a reduction in depth or width reduces the cross-sectional area of the river so there is a constant flow of water resulting in higher river velocity.

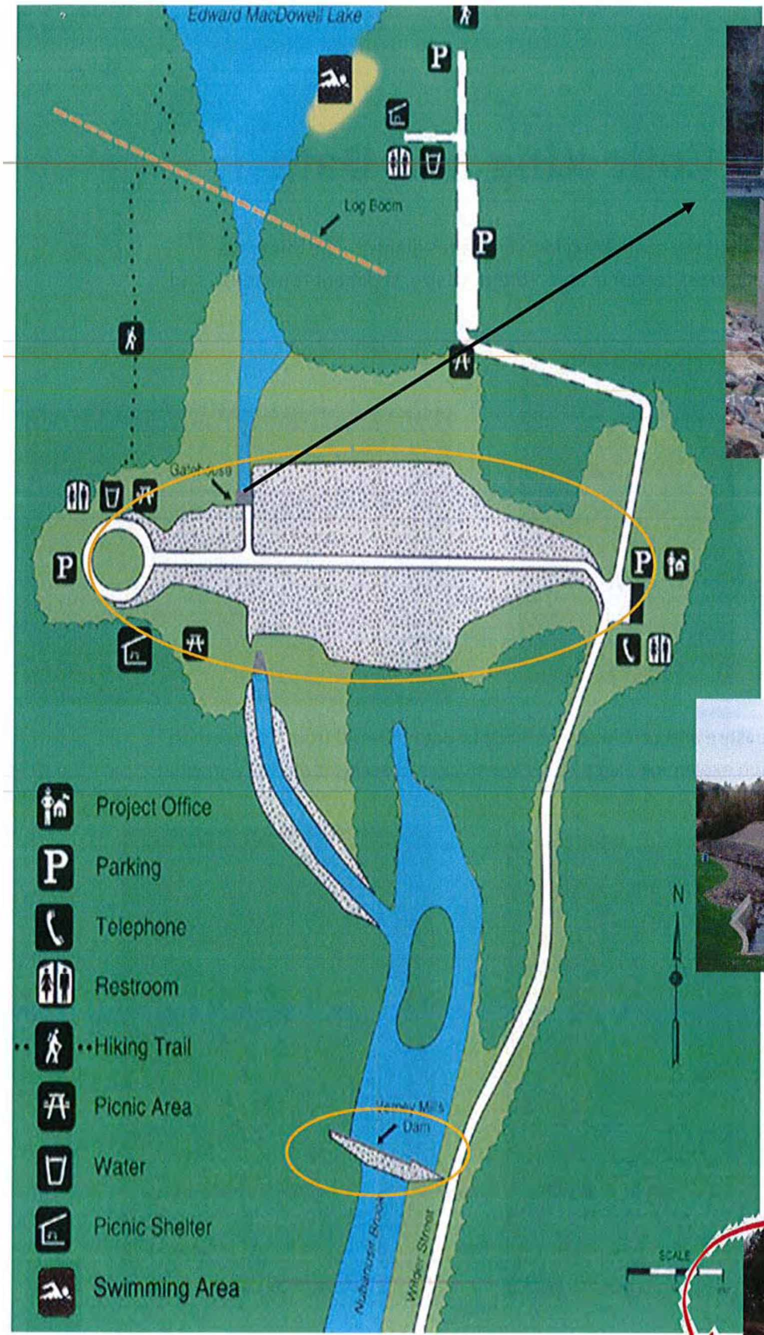
Before we got to measure the Nubanusit River we visited the Edward MacDowell Dam and talked about flood control. As you can see there is a yellow ring circling the Nubanusit River which is flowing into Dinsmore Pond. Sargent's camp can be seen on the right to the east.

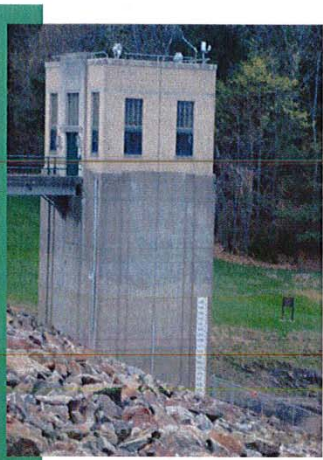
This map shows many things which we found out during our time measuring and furthermore we had to take these observations into consideration when getting our final readings and looking for correlations.

<u>Information on the river</u>

The River is 14.3 miles long and is a tributary of the Contoocook River and part of the Merrimack River Watershed. The Nubanusit River begins in Nelson, New Hampshire, and then flows south towards the Harrisville Pond and Skatutakee Lake. Then it flows east to the MacDowell Reservoir in Peterborough. The river keeps flowing south through villages and into the Drinsmore Pond until it then reaches the Contoocook River. As the river flows it is used for recreational purposes.

The map shows several manmade structures which will have an effect on the flow of rivers. For example, there are many roads meaning bridges were built to allow travel across the river. Therefore, the river would have been channeled and re-directed. There is also a spring and many flood control structures shown in gray.





Water flow is regulated through the dam when opening and closing the gates in the gatehouse. People who work there will lower the gates to hold back flood waters and raise the gates when the water is ready to be safely released downstream.

Additionally, at the Edward MacDowell dam more techniques are used for flood control which will affect the other rivers around it, including the Nubanusit. Above and below you can see sediment of different sizes and slopes as to keep the water flow structured.

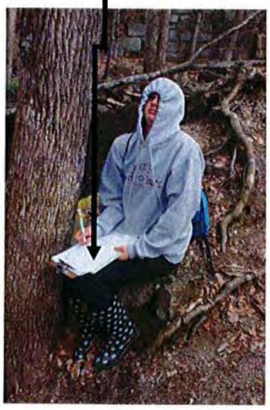
Method of Data Collecting and Data

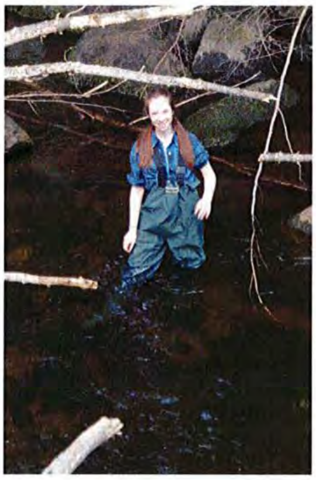
When we went to the river we measured the same thing in twenty sites along it. The things we measured were width, depth, velocity, cross sectional area, sediment size, sediment roundness, and sediment sphericity.

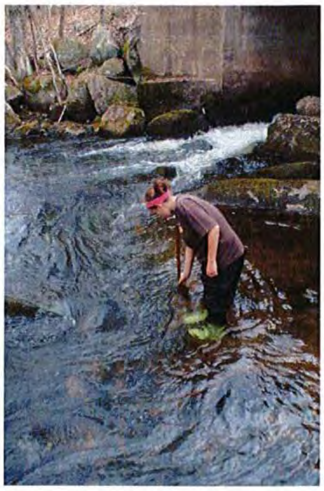
The equipment we used:

- Waders
- Clipboard
- Pencil
- Stopwatch
- Stick
- Tape measure
- Meter ruler
- Sediment chart
- Data collection sheet

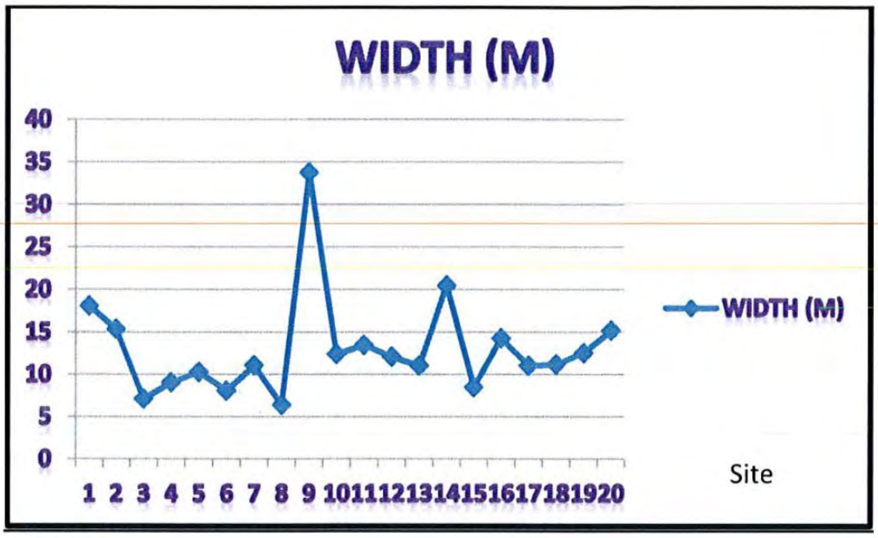
All of this equipment helped us measure and conclude whether our data differed from upstream to downstream. Below is an explanation explaining exactly how we measured each set of data and what we discovered.





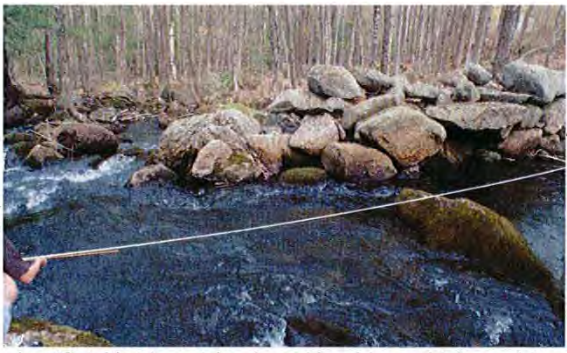


Width



To measure the width of the river we used a tape measure. We had one person standing at one side of the river and another person, cross over, to the other side. We did this at each of the 20 sites to see if our measurements would show any correlation. Our graph does not show much correlation as site nine is an anomaly, being nearly 35m wide while site 8 is 6m and site 10 is 13m. However, the first point is higher than the last points therefore we could say that this shows that, yes, at the top of a river the width is larger and at the bottom it gets narrower.

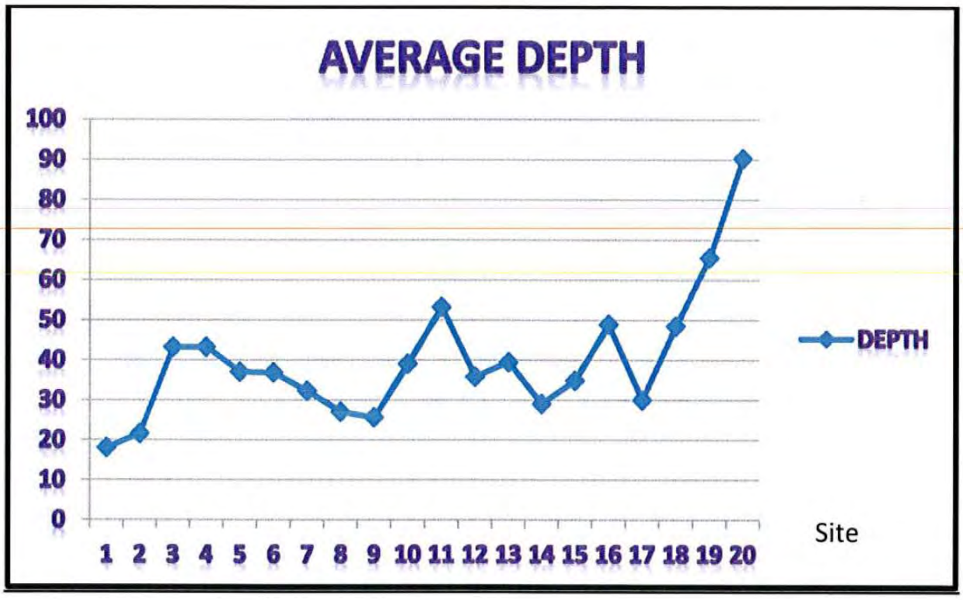
One person standing on one side of the river with a tape measure



Another person on the other side of the river holding the end of the tape measure

Some sites in the river had artificial bridges, islands and boulders which would push the water further out therefore creating a bigger width during the middle course and lower course of the river. Thus affecting our results; making them more irregular. Another factor is that in New Hampshire the most common rock is granite which erodes less due to the fact it is so hard and water erosion is less affective. In addition, in some places the river was braided due to a rock outcrop and changing width (therefore cross section) which might not have been accounted for in these areas when measuring.

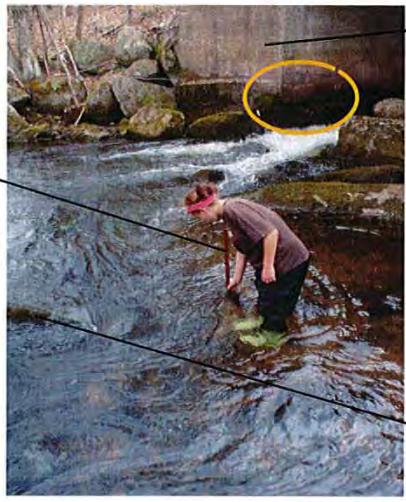
Depth



To measure the depth we took a meter stick and measured the river five times across the width of the river to get a fair amount of readings. We then found the average and plotted it on a graph to see if our results supported our prediction and the Bradshaw model. On our graph there is a noticeable difference in the depth from upstream to downstream which supports my prediction. This is shown because site 1 is nearly 20cm and site 20 is nearly 90cm. As we moved down the river we did get some inaccurate readings as some sites had a very rocky bottom with boulders, affecting our readings because we didn't get to the bottom of the river bed. For example, site 11 which is nearly 55cm.

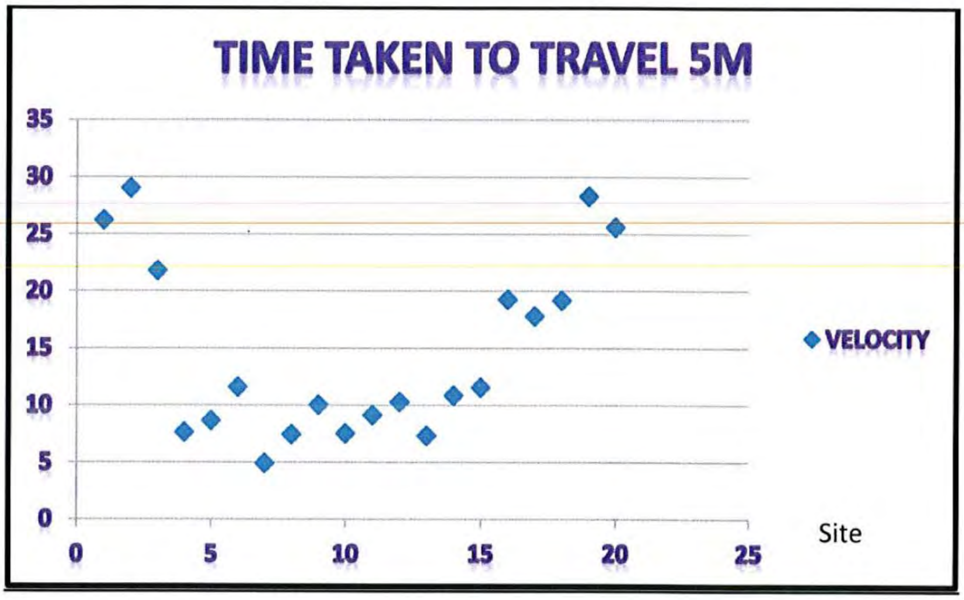
Artificial bridge which might have affected our results because the water (as shown in a yellow circle) has gained energy by being re directed.

Meter stick used to measure five points across the width of the river



Boulders stuck in the river bed also could have affected our results as we couldn't measure right down to the bed

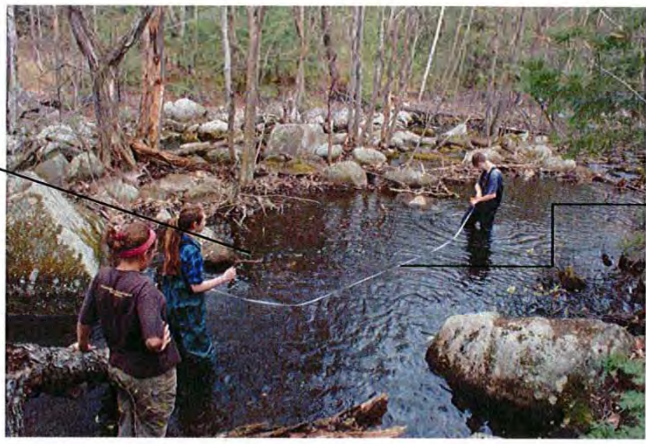
Time taken to travel 5m



This graph is representing the change in velocity as we move downstream. I predicted, and it is shown on the Bradshaw model, that velocity will increase as we go downstream due to more friction. However, our results do not support this. This is established by our readings which show no correlation. For example, site 1 is 29 seconds and site 5 is 8 seconds. We expected these readings to keep decreasing however when we got to site 20 it took 66seconds. This could be because there were bridges and islands which would change the speed and flow of the river and a lot of debris. Or because the fastest flow in deeper water occurs underneath the surface where there is no friction.

A · Use background information and theory to analyse relationships

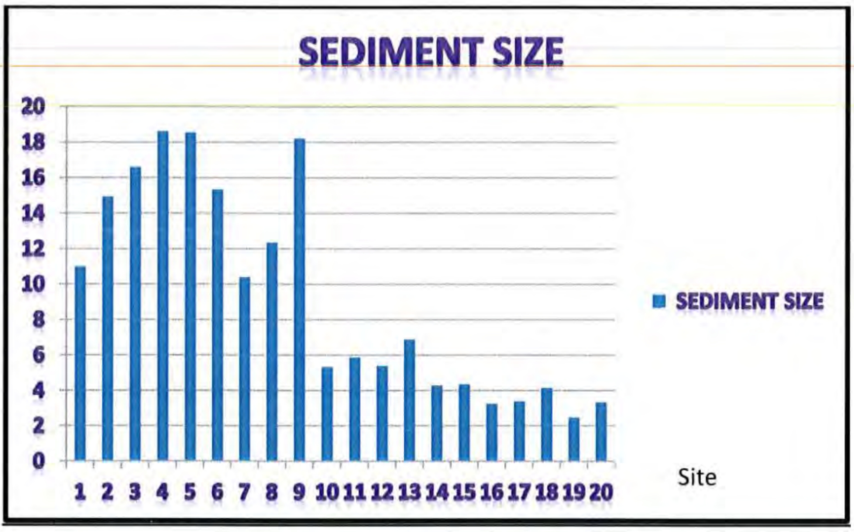
Stick- we dropped the stick at the beginning of the measuring tape and then timed how long it took to get five meters.



Tape measure showing five meters

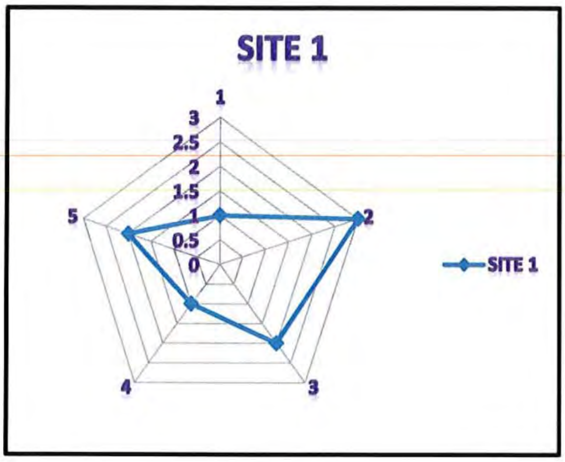
The test above was used for measuring the speed of flow. This could have been done more accurately if we measured the width of the site and stood right in the middle of it. Thus, ensuring each time we were measuring the flow from the middle of the river; or even easier and more accurately using a flow meter.

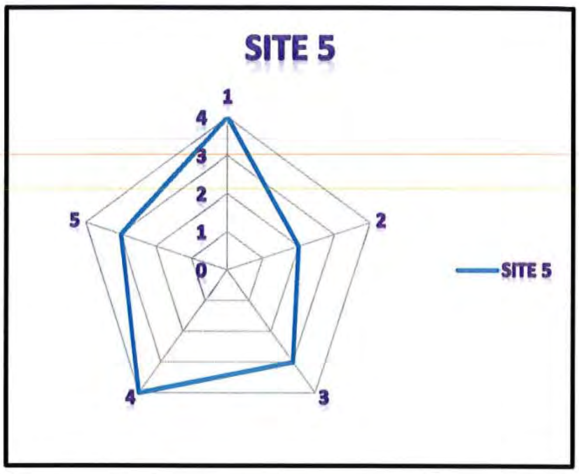
<u>Sediment size</u>

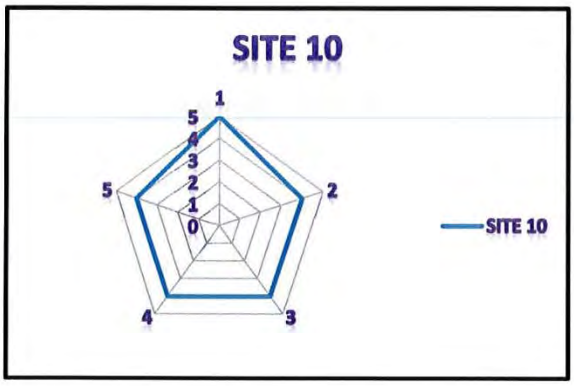


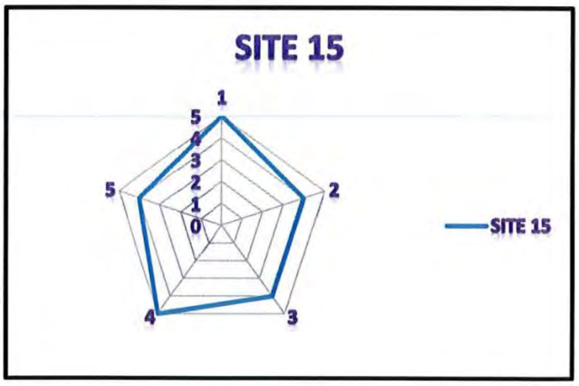
To measure sediment size we used a measuring tape and at each site measured five rocks. Therefore overall we had 100 rocks measured for accuracy. We tried to choose rocks from the sides and middle of the river however; sometimes this was not possible because the river was filled with massive boulders and logs (as well as drastic changes in depth). Our average sediment size does decrease eventually as the graph shows. However, site one had an average size of around 11cm and then site 2 has an average size of 15cm. This could have been caused because of the plunge pool. The plunge pool was caused by a lake which spilled over creating the source of our river. We also see a major difference in site 9 as it increases to around 18cm. These unpredictable numbers could again be caused by the artificial bridges affecting the natural flow. Also some sites had much more deposition on the edge of the river than others.

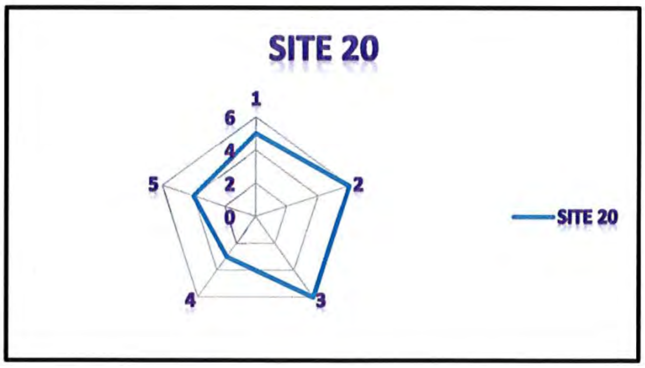
Sediment roundness



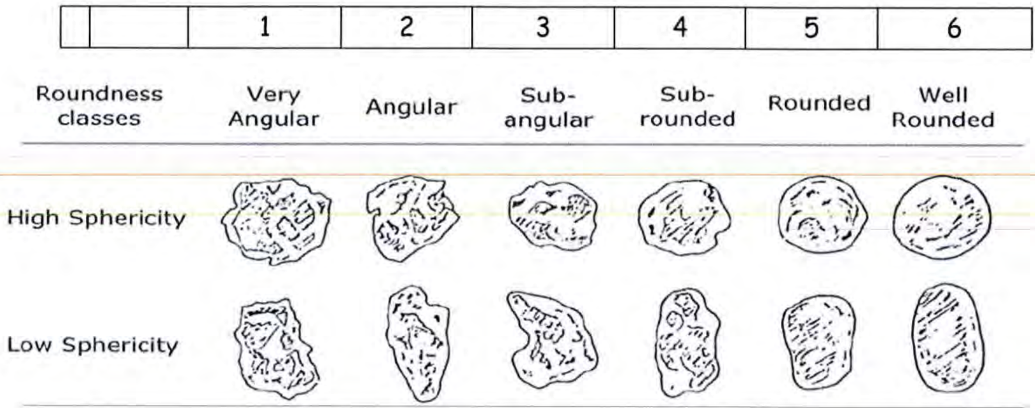








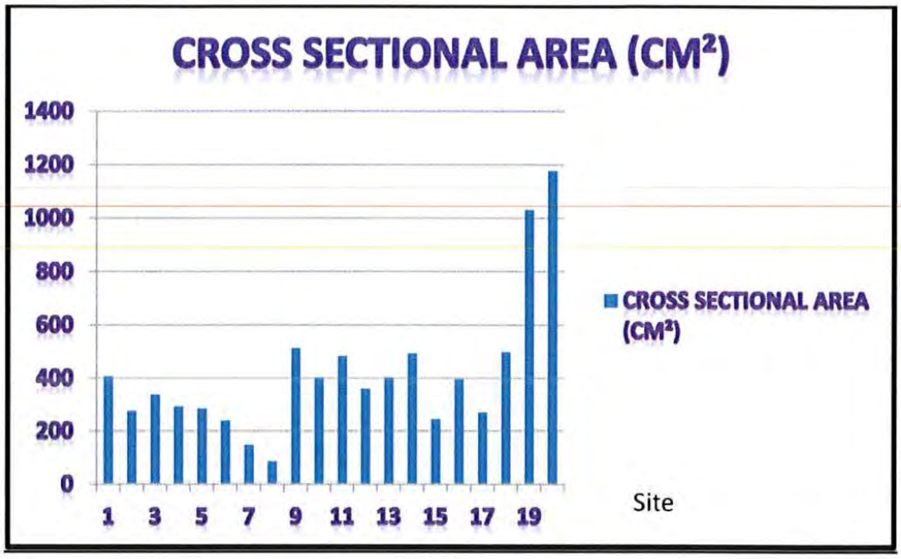
To measure sediment roundness we used the Sediment ranking graph as shown below.



At each site we measured five pebbles to see if as we went downstream the pebbles would become more rounded and less angular because of increased and constant erosion. Some of our results did support our predictions however, some did not. Above there are five radar graphs which are showing the average roundness of Sites 1, 5, 10, 15 and 20. At site 1 the sediment was quite small because there were big boulders which we could not pick up and measure. Therefore some of our data is biased, because it was easier for us to pick up and move deposit which we could handle and see. At sites 10 and 15 the line is in a more circular pattern showing how the rocks are becoming less angular and of higher sphericity.

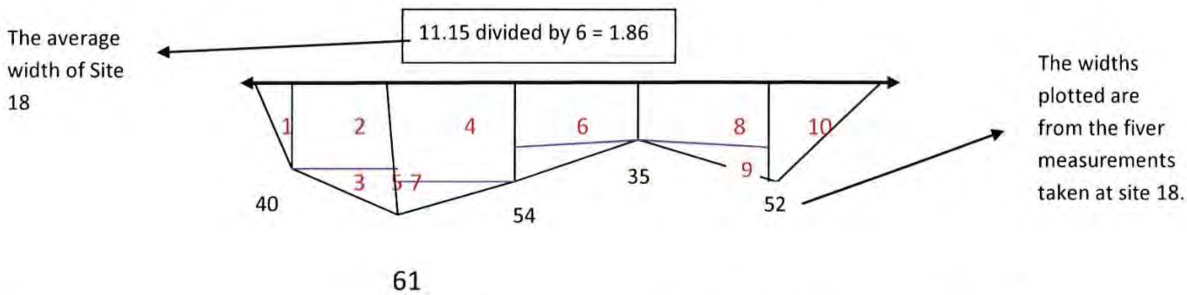
Sediment was taken from the river and then put next to the pebble ranking chart. The pebbles ranged from very angular – well rounded and either high sphericity or low sphericity.

Cross Sectional Area



The graph above is showing cross-sectional area. We did not make a prediction about this and this is not predicted in the Bradshaw model. Nevertheless, it was useful information because it does show an increase in cross sectional area as we head downstream. The noticeable difference from site 17 to site 20 may have been caused by human interference and less vegetation or trees. The results are not a constant increase for example; site 8 and site 9 have a big difference in size.

A diagram is drawn below as an example of how we came about the existing figures. Here is a worked example for site 18.



For every triangle: 1.86*n divided 2 =x

For every square: 1.86*n =x

All of these numbers are then added up to find the total cross sectional area:

1) 1.86*40 divided by 2= 37.2

2) 1.86* 40 = 74.4

a3) 19.53

4) 113.46

5) 6.51

6) 100.44

7) 17.67

8) 65.1

9)15.81

10) 48.36

37.2
74.4
19.53
113.46
6.51
100.44
17.67
65.1
15.81
48.36

\+ = 498.48

This method was very efficient and gave us an idea of what was going on with the river. This wasn't the most accurate technique but by drawing on the 5 points of width and changing the steepness of the line according to number values we get a good visual as well as a final concluded answer that yes, cross sectional area increases as the river heads downstream.

Spearman's Rank

Spearman's rank is a statistical test to distinguish if there is any correlation with data and how much that relationship is. Below is an example of how we compared two sets of data to find correlation.

The first thing we did was rank all of our data. The highest value is ranked with number 1 and the lowest value number ranked 20.

Site	Width	Rank	Depth	Rank	d	d^2
1	18.05	3	1.8	20	17	289
2	15.3	4	2.4	18	14	196
3	7.08	19	3	15	-4	16
4	9.02	16	3.6	13	-3	9
5	10.25	15	3.2	14	-1	1
6	8.05	18	4.2	10	-8	64
7	11.05	12	2.4	18	6	36
8	6.36	20	3	15	-5	25
9	33.75	1	2.8	17	16	256
10	12.38	9	4.2	10	1	1
11	13.45	7	4.6	3	-4	16
12	12.07	10	4.4	5	-5	25
13	11.01	13	4.4	5	-8	64
14	20.42	2	4.4	5	3	9
15	8.47	17	4.4	5	-12	144
16	14.26	6	3.8	12	6	36
17	11	14	5.2	1	-13	169
18	11.15	11	4.4	5	-6	36
19	12.5	8	4.6	3	-5	25
20	15.15	5	4.8	2	-3	9
					Σd^2	1426

When all of *d* was calculated there were negative figures therefore we calculated *d^2* to eliminate the negative values.

After we had all of our rankings completed we figured out the difference (d) between the two rankings. For example, site 1 we took the second rank column and took the first rank column away from it ; 20-3 =17.

Finally, we added up all of the d squared values.

We now had all the information required to calculate the correlation coefficient, or r, by using the formula:

$$r = 1 - \frac{6\Sigma d^2}{n^3 - n}$$

Using this formula we were able to work out whether our data had a strong positive or negative correlation and here are the results:

Width	Depth	-0.18
Width	Sediment size	-0.31
Width	Velocity	-0.35
Depth	Velocity	-0.24
Depth	Sediment size	0.5
Depth	Sediment roundness	-0.5
Cross sectional area	Sediment size	-0.38
Sediment size	Sediment roundness	-0.68
Velocity	Sediment Size	-0.35
Velocity	Sediment Roundness	-0.13
Width	Sediment roundness	-0.07
Cross sectional area	Depth	0.41
Cross sectional area	Width	0.69
Cross sectional area	Sediment roundness	0.32
Cross sectional area	Velocity	-0.33

All the values which are closest to positive one or negative one are the stronger correlations . For example, cross-sectional area and width has a very strong correlation 0.69. This is because the wider it is the larger the cross- sectional area and vice versa. Another strong correlation was sediment size and sediment roundness being -0.68. This was strong because the smaller and rounder the rock the more erosion which has occurred to it while in the river bed.

However, this is just a statistic and we cannot be totally sure as things may have occurred by chance.

Conclusion of final data

Overall, our data does show some useful and positive correlations. However, we did have a few minor issues including: we had limited equipment, there were manmade structures near some of our reliability of our results) and we took our readings over a two day period meaning the rain we had over one night may have affected and changed what our readings were for the next day. On the other hand, considering our limitations I believe we concluded this river evaluation quite accuratly.

Below are readings shown for the sediment concluding the fact that size, erosion and transportation was definitely occurring. Also many of my predictions were supported. Below is a final statement for each of my predictions according to what we found.

- Particle size will decrease downstream – This was supported by our readings as visibly there were more small pebbles and less boulders. And our results show the decrease in size as well due to erosion.
- The channel depth will increase- This was supported by our readings. The more we headed downstream the larger the values became.The bed rock in New Hampshire is granite. This is why NH is called the granite state and therefore erosion is more likely to erode laterally than vertically down.
- The width will increase- This was not fully supported by our readings. This was because of the artificial bridges and debris throughout the river. Also because of the granite rock which is not as susceptible to water erosion. For example, site one was 18m and site 20 was 15m.
- Sediment shape will change- This was supported by our readings as the rocks went from very angular with a low sphericity to being well rounded with a low sphericity.
- Velocity will increase- This was not fully supported by our results. This again could have been due to manmade structures and the increasing depth of the river. Also by the fact that we did not have proper equipment for measuring velocity.

Lastly, we managed to get more sites done than anticipated which meant we got more analysis increasing our accuracy.

Next time, if we were to go again, we would need to bring more equipment including a flow meter, a variety of measuring rods and micrometers to measure sediment diameters. Also more planning ahead of time would have ensured a larger variety of river readings. Furthermore, if we allowed more time to ensurure all of our readings had been taken on the same day we wouldn't have had to have taken account the rain which occurred over night thus changing our results. All in all, further research of the river would be needed in order to validate and confirm our conclusions.

Resources

http://geobytesgcse.blogspot.com/2006/11/river-processes.html

http://en.wikipedia.org/wiki/Bradshaw_model

http://en.wikipedia.org/wiki/Spearman's_rank_correlation_coefficient

A series of Geography reverence books found at my school for example: The Cambridge IGCSE Geography Coursebook.

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