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River Ilston

FIELDWORK ASSIGNMENT

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Introduction

Background

Rivers are constantly changing.

Typical changes along the length of a river can be demonstrated using the Bradshaw model.

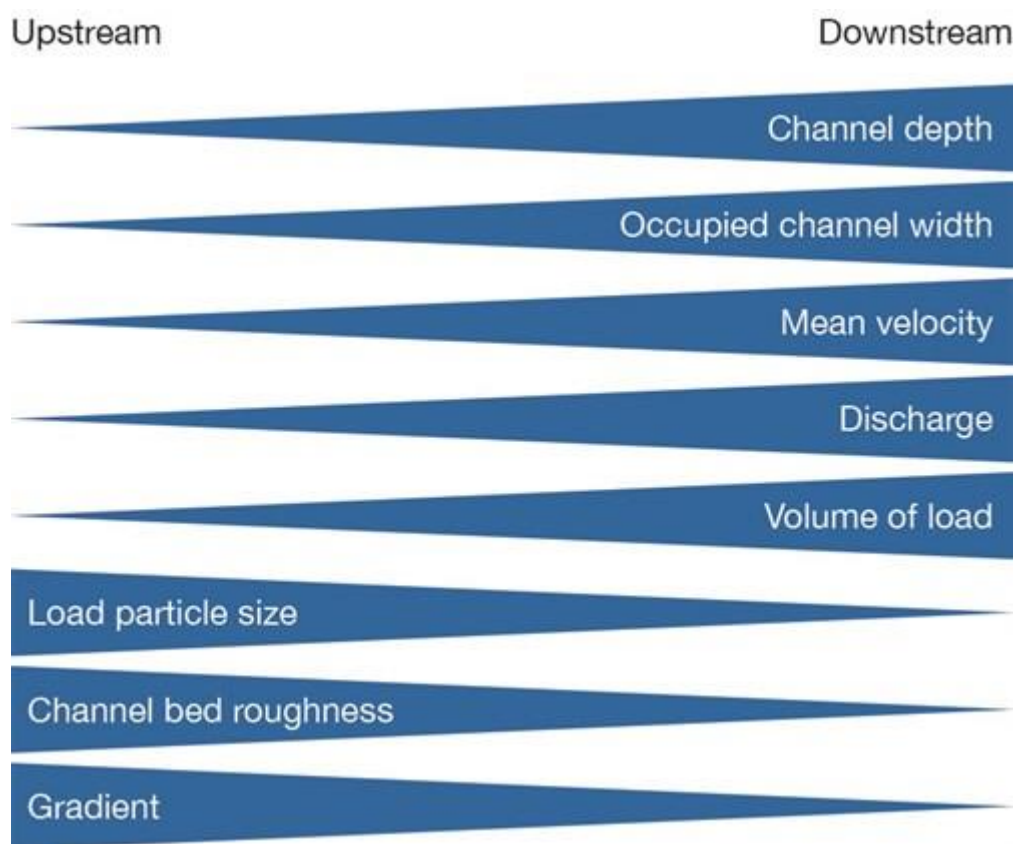


Figure 1. Bradshaw model shows characteristics which typically increase (i.e. channel depth, occupied channel width, discharge and volume of load) and those which typically decrease (i.e. load particle size, channel bed roughness and gradient) downstream of rivers. (Field Studies Council, 2023)

There are many environmental factors affecting the rise and fall of a river level, for example, rainfall and frost erosion, which affect these characteristics. (Lawler, 1986)

The cause of changes in characteristics can be anthropogenic such as sewage dumping and building on nearby land increasing surface run-off. (Field Studies Council, 2023)

Rationale

The purpose of this study is to investigate the following hypotheses, to identify and analyse changes in characteristics for River Ilston:

Hypotheses

1. The river becomes wider and deeper downstream
2. The cross-sectional area of the river increases downstream
3. The river velocity increases on the outside of a meander
4. The highest velocity is to be found in the centre of the river
5. The river velocity decreases downstream
6. The size of the bed load gets smaller downstream
7. The shape of the bed load becomes more rounded downstream
8. The discharge of water in the river increases downstream

Location

The River Ilston drains a catchment area of 30km² on Gower, Swansea. (Lawler, 1986) It's source is close to Swansea Airfield; it flows through the villages of Ilston and Parkmill and out to Three cliffs bay. Flowing through a valley, it is a 'misfit' river, i.e. a river too minor to have been responsible for the valley in which it runs. (Student, n.d.) In Late Devensian, Swansea district was invaded by valley glaciers carving out the landscape. (The British Geological Society, 2024)

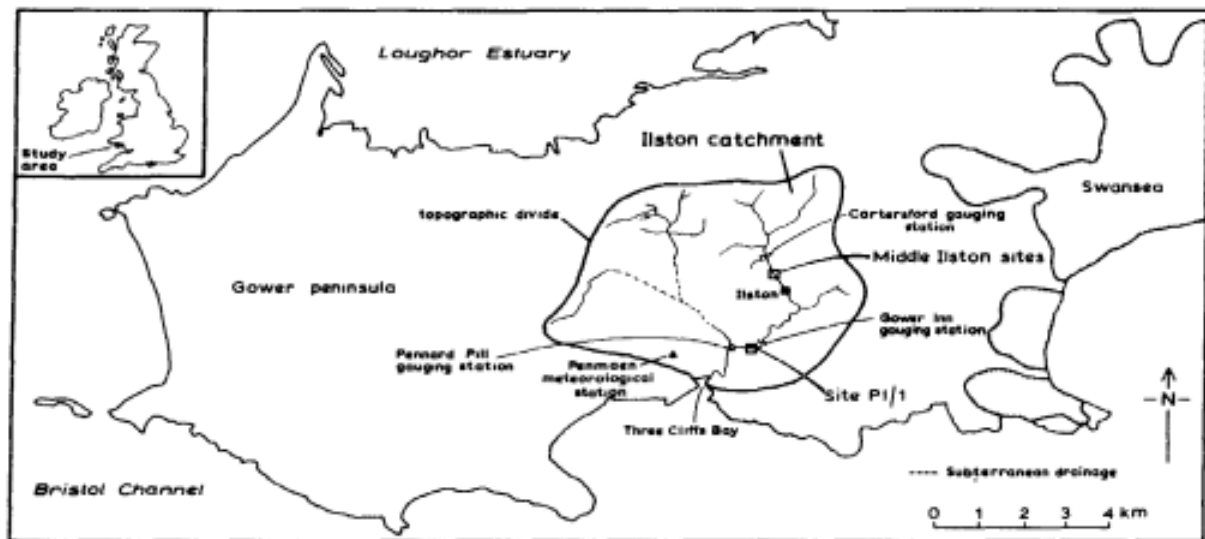


Figure 2. Location of the Ilston catchment on Gower (Lawler, 1986)

Swansea Airport is an extensive area, with surface run-off potentially impacting flood risk from the nearby River Ilston. However, although there were major floods in years 1942-1945 (UWTSD, 2023), current day flood risk maps show reasonably restricted flood risk areas for River Ilston (Figure 3).

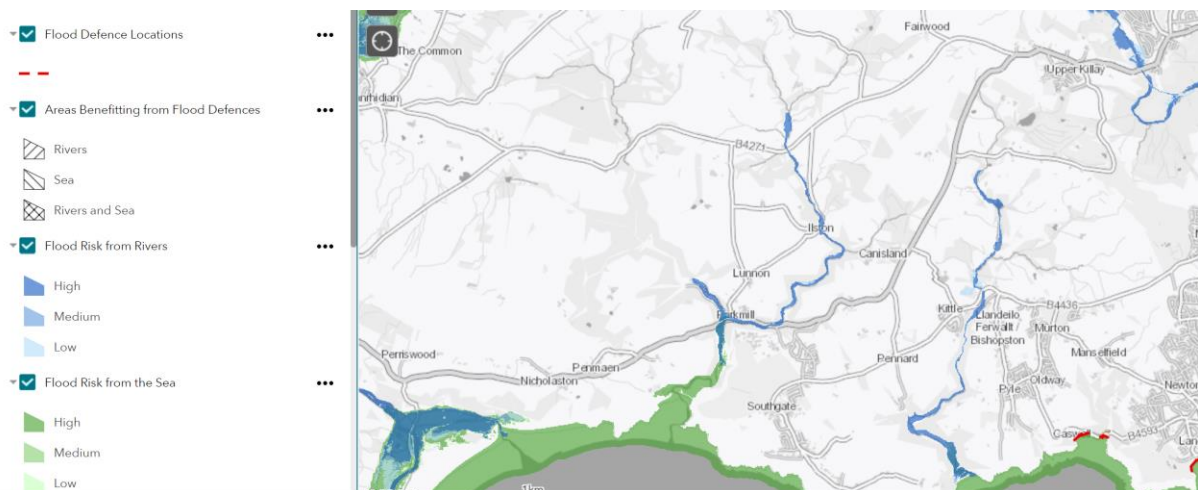


Figure 3. Current flood risk types for areas around River Ilston (Natural Resources Wales, 2023) shows well confined but high flood risk around the River Ilston, which becomes affected downstream by more extensive (less confined) high flood risk from the sea.

Methodology

Apparatus

- 1:25000 Map (Photocopy/mobile phone app) showing the location of group work
- Datasheets
- 25m tape measure
- Metre rule
- Clipboard
- Stopwatch
- 2 surveying poles
- Oranges
- Current flow meter
- Waders
- Powers Scale of roundness chart



Figure 4. Satellite view showing sites studied along River Ilston in Swansea, Gower (UWTSD, 2024)

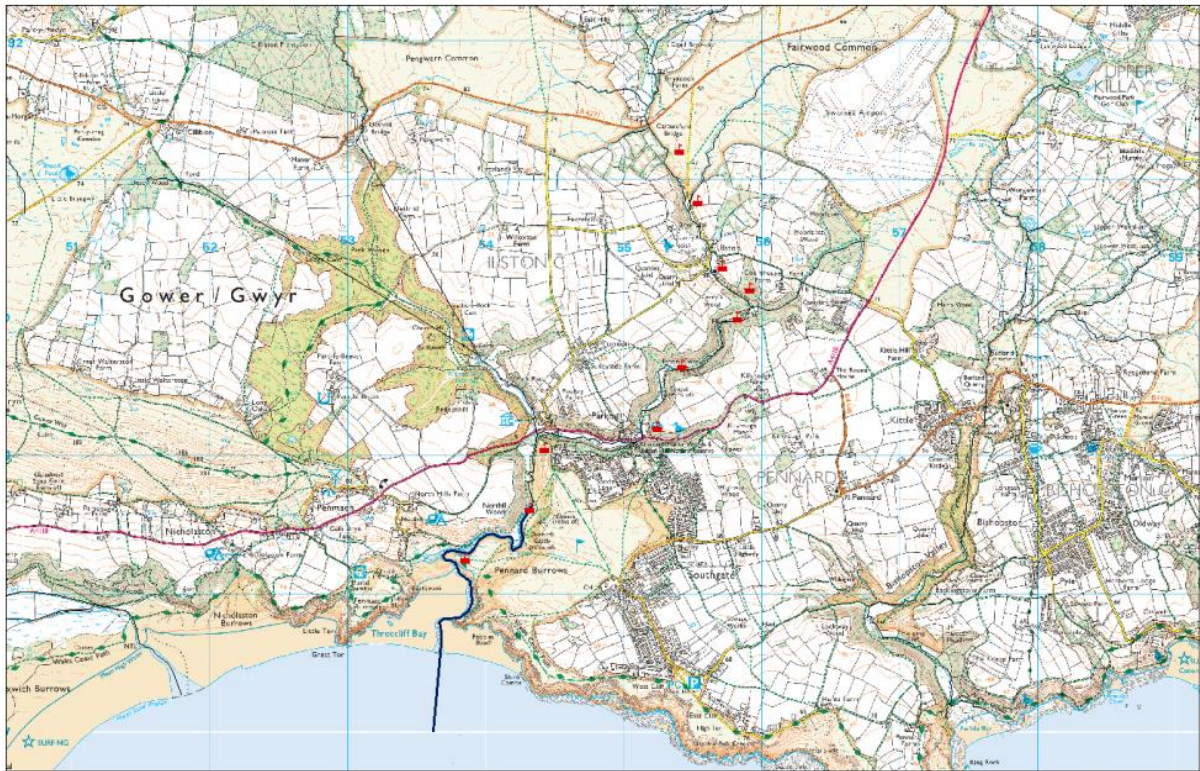


Figure 5. OS maps view showing sites studied along River Ilston in Swansea, Gower (UWTSD, 2024)

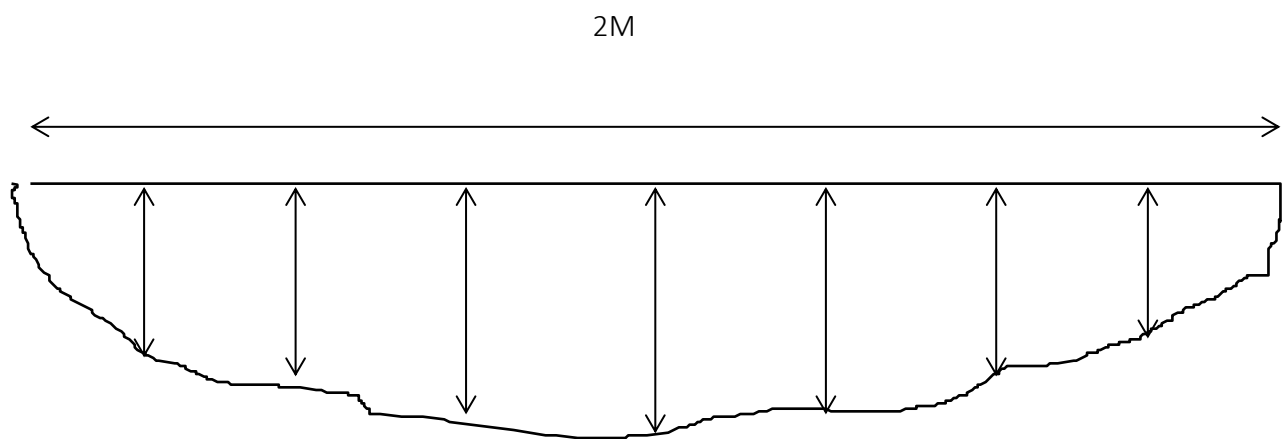
During a one day fieldtrip, two groups of students were designated to two different areas (upstream and downstream) of the River Ilston. For each area, five sites along the length of the river were chosen with consideration to suitability for this study as well as health and safety. (Figures 4&5). (Measuring the velocity of the river required a reasonably straight section of river at each site, so this was a factor in the decision making).

At each site, waders were worn and the width of a cross-section of the river was measured using surveying poles at opposite river banks. The tape measure was held taut between the surveying poles. A metre rule was placed upright, and readings were taken from the bottom to the surface of the river, every 25cm along the tape measure and recorded in a datasheet. The velocity of the river was also recorded using a flow meter at each site.

A length of five metres was measured from the cross-section to a student stood approximately in the middle of the river (with consideration to health and safety). Another student stood at the cross-section (5m upstream) approximately in the middle of the river also (with consideration to health and safety) and placed an orange carefully in the river. The time it took for the orange to travel (floating) five metres downstream, and reach the student there, was recorded in a datasheet using a stopwatch.

The longitudinal axis was measured for 5-10 samples of bedload, and their angularity (or roundness) was assessed using Power's scale of roundness chart and recorded in a datasheet.

The average depth and cross sectional area at each site was calculated using the following example formula:



Readings 1 - 7

1 - 0.20m

2 - 0.25m

3 - 0.50m

4 - 0.60m

5 - 0.45m

6 - 0.20m

7 - 0.10m

Total 2.3m

Average depth = Total depth/(n+1)

$$\frac{2.3}{8} = 0.288$$

$$\text{Cross Sectional area} = 2 \text{ (width)} * 0.288 \text{ (average depth)} = 0.576 \text{ m}^2$$

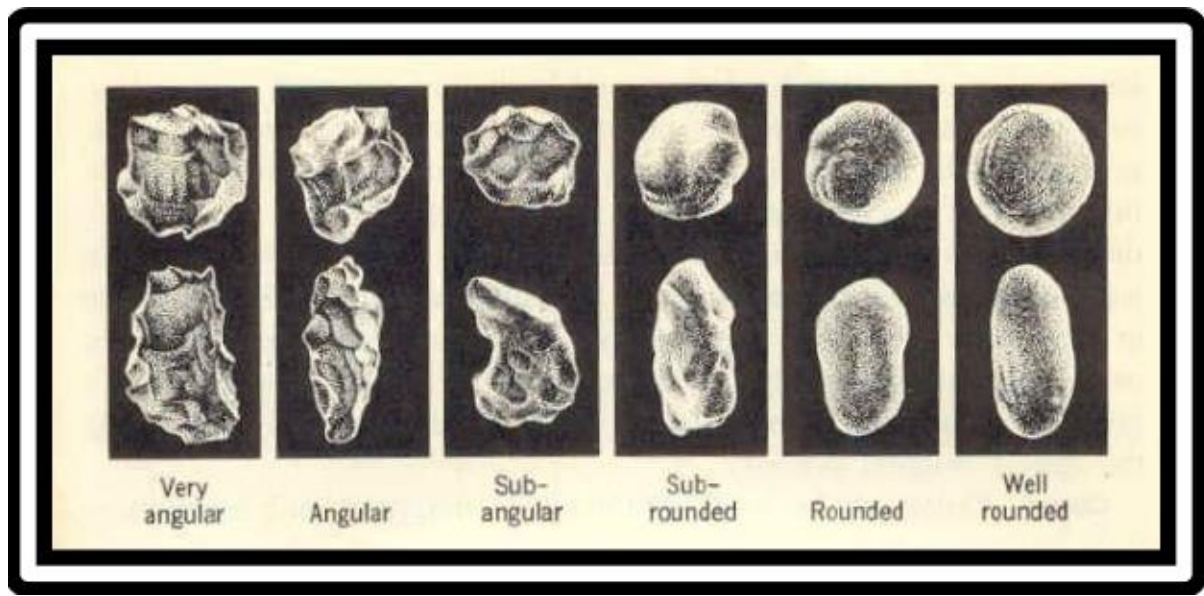


Figure 6. Power's scale of roundness chart (UWTSD, 2024)

Results and analysis

Hypothesis 1. The river becomes wider and deeper downstream

Hypothesis 2. The cross-sectional area of the river increases downstream

	Depth (centimetres)									
Distance (metres)	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
0.25	9.67	4	7	5	12.5	6	3	17	30	8
0.5	12	5	10.5	16	16	11	5.5	38	27	13
0.75	18	9	13.5	28	19	10	6.5	40	30	18
1	20.67	18	15	32	19.5	13	7	39	30	22
1.25	28.5	17	19.5	30	22.5	14	8.5	38	30	22
1.5	21.33	22	20.5	24	24.5	16	12.5	35	32	26

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Table 1. Depths at 0.25 metre intervals at each cross section for 10 consecutive sites along River Ilston (From 1=upstream to 10=downstream)

Site	Average depth (cm)	Width (m)	Cross sectional area (m ²)
1	16.15385	2.267	0.366208
2	12.75	3.1	0.39525
3	20.75	6.9	1.43175
4	16	3.8	0.608
5	31.21154	5.8	1.810269
6	13.5625	0.25	0.033906
7	9.930556	8.625	0.85651
8	17.11538	2.267	0.388006
9	28.12903	2.267	0.637685
10	24.2766	2.267	0.55035

Table 2. Average depth (centimetres), width (metres) and cross sectional area (metres²) for 10 consecutive sites along River Ilston (From 1=upstream to 10=downstream)

Spearman's correlation between average depth and width	-0.31
Pearson's correlation between average depth and width	-0.18
Spearman's correlation between site and cross sectional area	-0.18
Pearson's correlation between site and cross sectional area	-0.09
Spearman's correlation between site and average depth	0.33
Pearson's correlation between site and average depth	0.33

Spearman's correlation between site and width	-0.24
Pearson's correlation between site and width	-0.13

Table 3. Spearman's and Pearson's correlation coefficients for all measurements in Table 2.

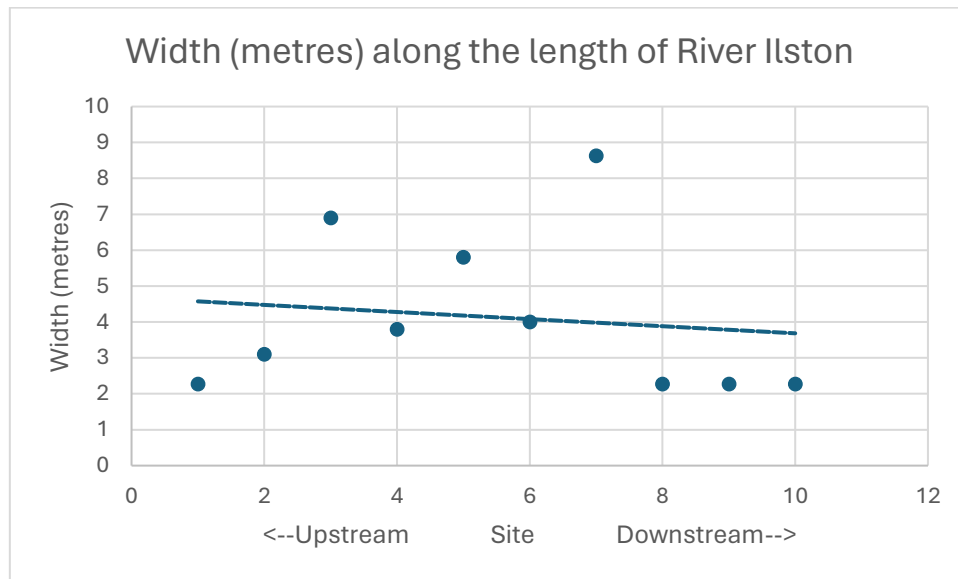


Figure 7. Width (metres) at 10 consecutive sites along River Ilston (From 1=upstream to 10=downstream)

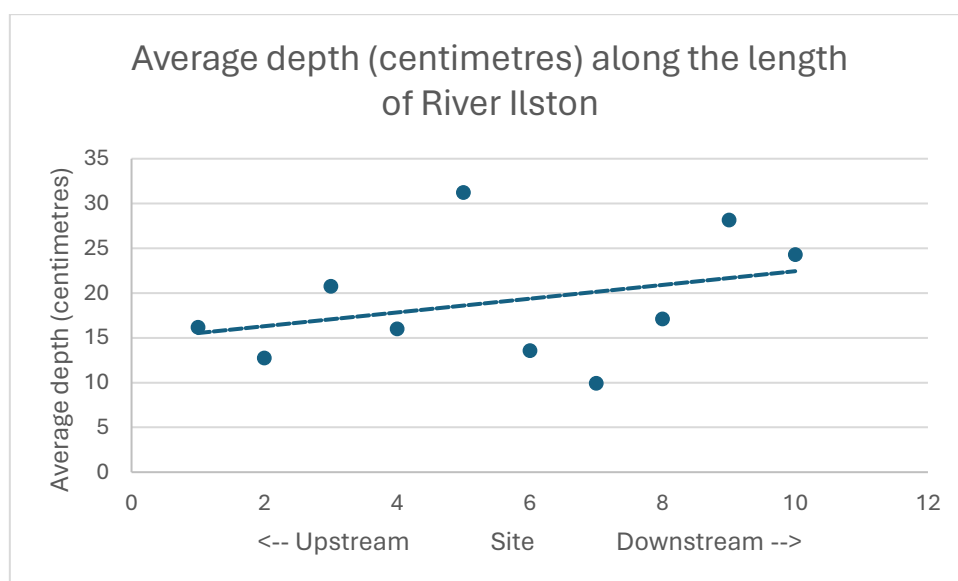


Figure 8. Average depth (centimetres) at 10 consecutive sites along River Ilston (From 1=upstream to 10=downstream)

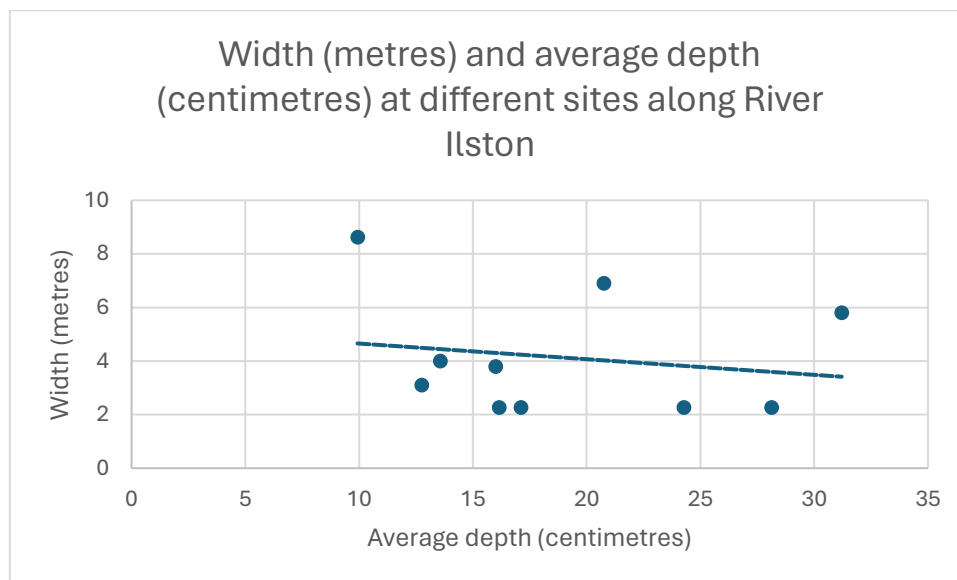


Figure 9. Width (metres) and average depth (centimetres) at different sites along River Ilston

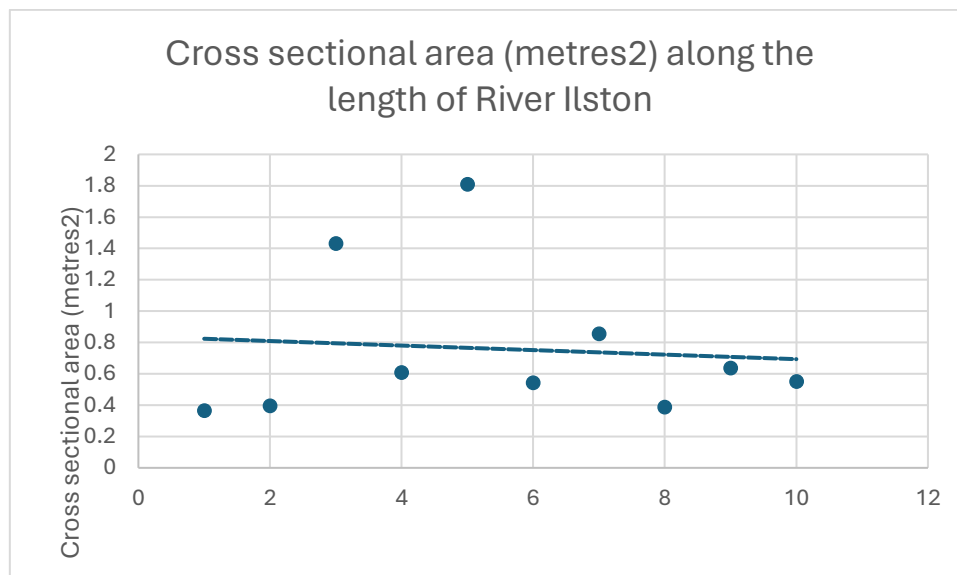


Figure 10. Cross sectional area (metres²) at 10 consecutive sites along River Ilston (From 1=upstream to 10=downstream)

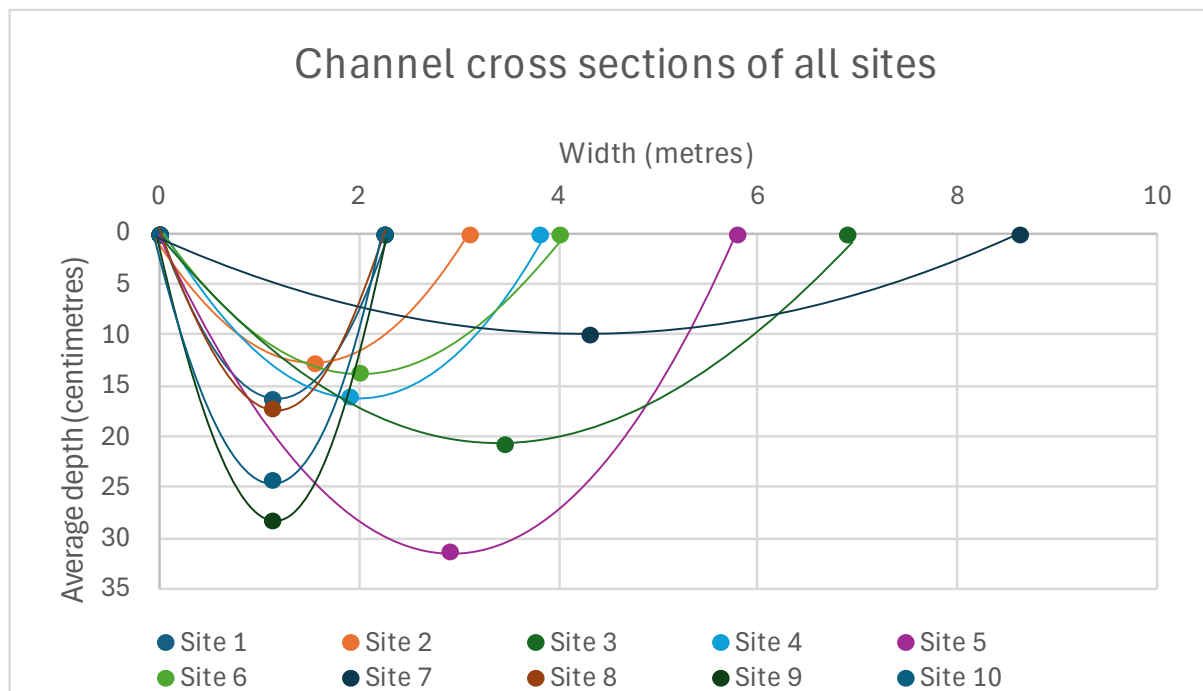


Figure 11. Channel cross sections showing average depth and width for 10 sites along River Ilston

The Spearman's and Pearson's correlation coefficients for relationships between "site and width", "site and cross-sectional area" and "average depth and width" are all negative, meaning there is an inverse relationship between the two variables being investigated. The positive coefficient for "site and average depth" means there is a direct relationship between these two variables. All values are either "weak" or "very weak", meaning there is not much correlation (relationship) between any of the variables. The river becomes slightly deeper, but also slightly narrower, downstream, partly refuting hypothesis 1 that it gets deeper and wider downstream. The cross sectional area slightly decreases downstream, refuting hypothesis 2 that it increases downstream.

Hypothesis 3. The river velocity increases on the outside of a meander

Hypothesis 4. The highest velocity is to be found in the centre of the river

Hypotheses 3&4 were not observed due to unsuitability of river conditions.

Hypothesis 5. The river velocity decreases downstream

Site	Flow meter readings					Average velocity (m/s)
	Velocity (m/s)					
	1	2	3	4	5	
1	0.5	0.55	0.4	0.2	0.2	0.37
2	0.005	0.356	0.322	0.289	0	0.19
3	0.45	0.47	0.35	0.3	0.4	0.39
4	0.006	0.22	0,091	0.32	0.225	0.19
5	0.37	0.55	0.48	0.34	0.4	0.43
6	0.244	0.244	0,410	0,196	0.015	0.17
7	0.3	0.42	0.72	0.59	0.4	0.49
8	0.51	0.58	0.54	0.37	0.4	0.48
9	0.22	0.51	0.43	0.26	0.1	0.30
10	0.07	0.32	0.33	0.26	0.25	0.25

Table 4. Flow meter velocity readings (metres/second) along length of River Ilston with calculated averages.

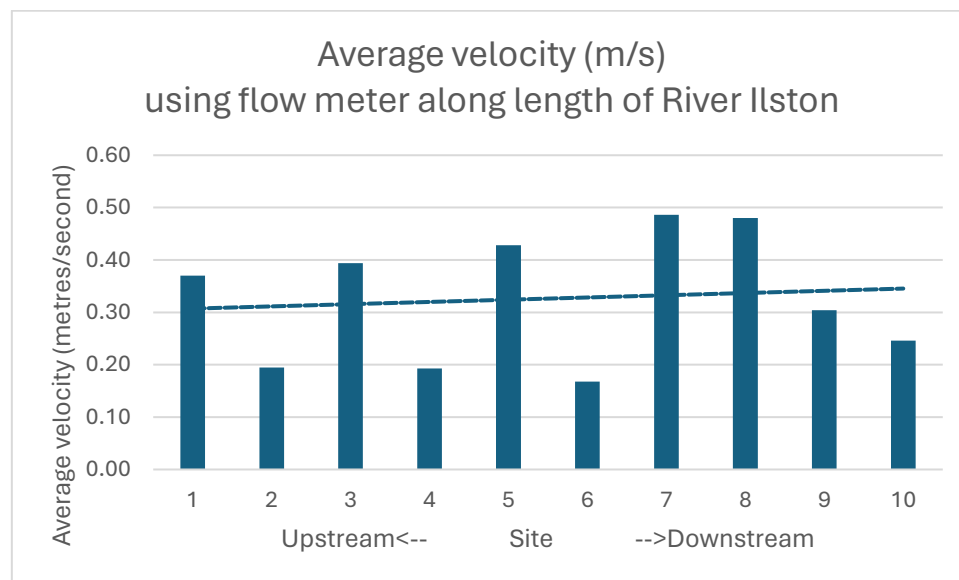


Figure 12. Graph showing average velocity (metres/second) with consecutive sites along River Ilston (From 1=upstream to 10=downstream)

Spearman's correlation between site and average velocity (using flow meter)	0.14
Pearson's correlation between site and average velocity (using flow meter)	0.11

Table 5. Spearman's and Pearson's correlation coefficients for site and average velocity using flow meter

Site	Time(s)					Average time (s)	Average velocity (m/s)
	Samples						
	1	2	3	4	5		
1	9.6	12.1	11.3	13.1	8.9	11.00	0.45
2	8.6	8.9	9.3	7.9	7.5	8.44	0.59
3	54	19.3	15.1	24.3	37.7	30.08	0.17
4	6.8	4.6	5.2	5	5.9	5.50	0.91
5	21.6	16.4	15.2	22.6	15	18.16	0.28
6	9.9	9.4	8.5	8.8	8.4	9.00	0.56
7	6	6.8	11.4	11	7.9	8.62	0.58
8	6.93	6.48	7.29	6.66	6.61	6.79	0.74
9	10.21	10.8	9.18	8.14	8.82	9.43	0.53
10	28.89	35.32	29.56	28.75	24.16	29.34	0.17

Table 6. Orange time readings (seconds) along length of River Ilston with calculated velocity (metres/second) averages

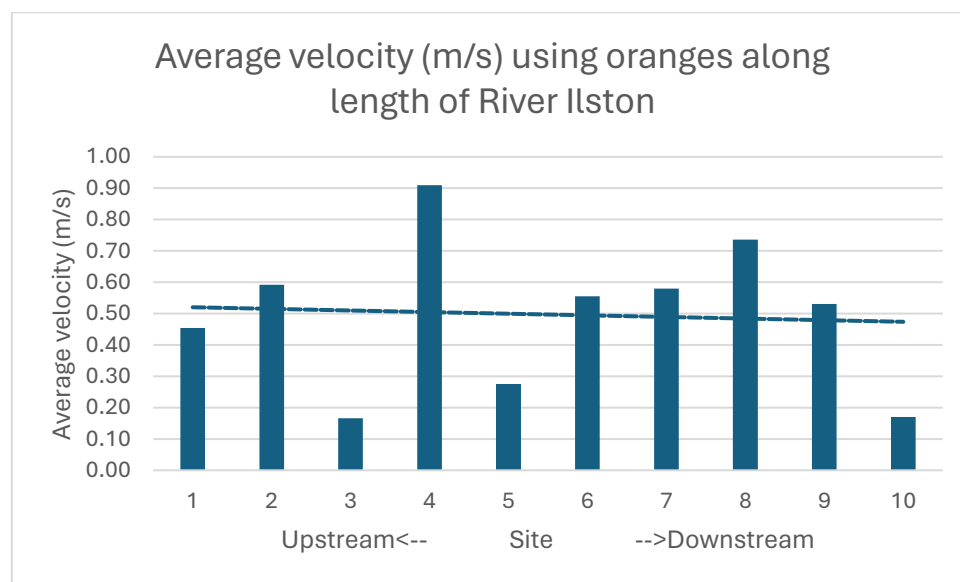


Figure 13. Graph showing average velocity (metres/second) for consecutive sites along River Ilston (From 1=upstream to 10=downstream)

Spearman's correlation between site and average velocity (using oranges)	-0.03
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Pearson's correlation between site and average velocity (using oranges)	-0.07
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Table 7. Spearman's and Pearson's correlation coefficients for site and average velocity using oranges

Spearman's and Pearson's correlation coefficients show a "very weak" positive correlation between average velocity and site using flow meter readings, meaning that the average velocity very slightly increases downstream, refuting hypothesis 5 that the river velocity decreases downstream. However, the coefficients show a "very weak" negative correlation between average velocity and site using orange readings, meaning that the average velocity does decrease slightly downstream, supporting hypothesis 5.

6. The size of the bedload gets smaller downstream

	Site							
Sample	1	2	3	4	5	6	7	8
1	18	12	10	12	9	9	5	6
2	14	16	13	16	13	8	9	5
3	11	11	11	13	10	5	8	5
4	15	15	11	15	6	7	8	4
5	13	13	13	11	9	10	7	4
6					12		5	
7					10		6	
8					3		9	
9					9		6	
10					5		9	
Average longitudinal axis	14.2	13.4	11.6	13.4	8.6	7.8	7.2	4.8

Table 8. Average longitudinal axis calculations of 5-10 representative samples of bedload taken for 8 consecutive sites along River Ilston (from 1=upstream to 8=downstream). Sand from sites 9&10 not measured.

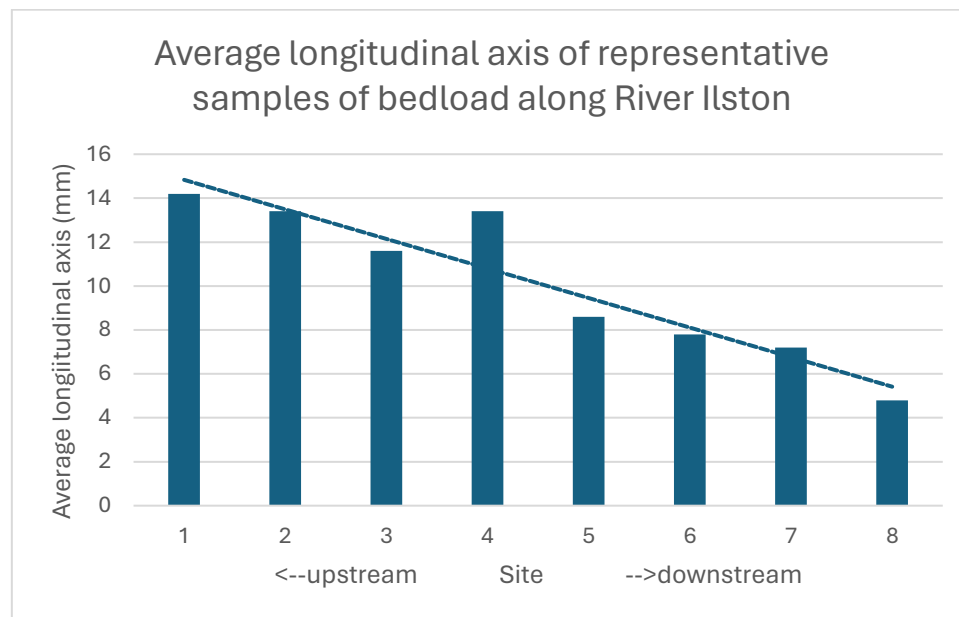


Figure 14. Graph showing average longitudinal axis (millimetres) along consecutive sites of River Ilston (from 1=upstream to 10=downstream)

Spearman's correlation between site and average longitudinal axis of representative samples of bedload	-0.96
Pearson's correlation between site and average longitudinal axis of representative samples of bedload	-0.95

Table 9. Spearman's and Pearson's correlation coefficients for site and average longitudinal axis of representative samples of bedload

Spearman's and Pearson's correlation coefficients show a "very strong" negative correlation between site and average longitudinal axis of representative bedload samples, meaning that there is a statistically significant relationship between the site and the size of the bedload, with the size of bedload decreasing downstream, supporting hypothesis 6.

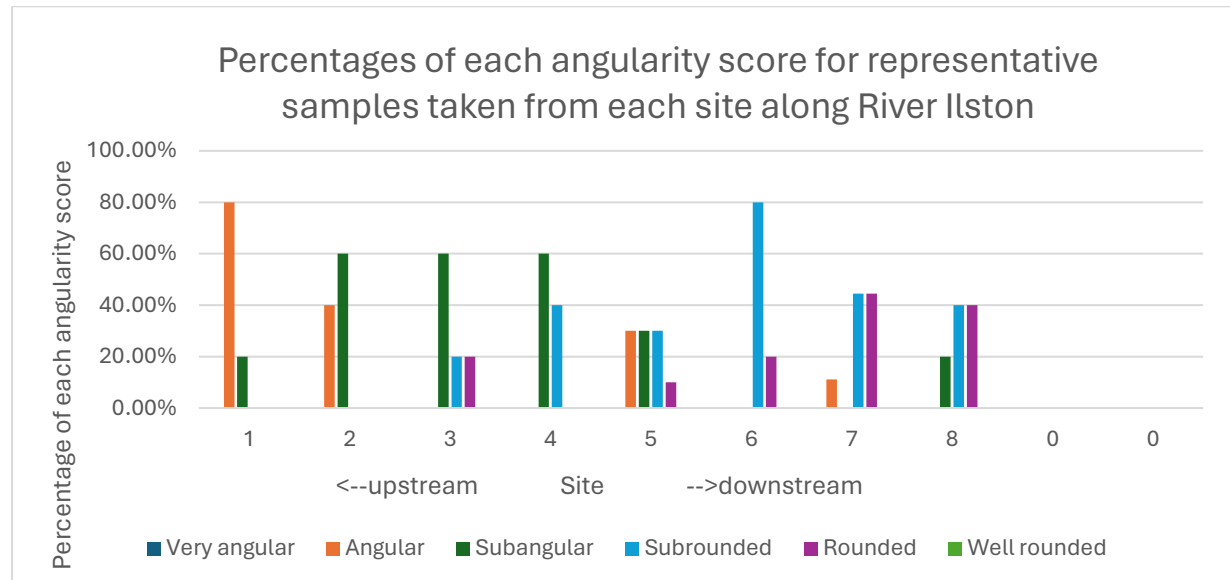
7. The shape of the bed load becomes more rounded downstream

Figure 15. Graph showing percentage of each angularity score for representative samples taken from each consecutive site along River Ilston (from 1=upstream to 10=downstream)

The graph demonstrates that the shape of the bedload generally changes from high percentages of “angular” and “subangular” bedload upstream to lower percentages downstream and, vice versa, high percentages of “subrounded” and “rounded” bedload downstream to lower percentages upstream. This data supports hypothesis 7.

8. The discharge of water in the river increases downstream

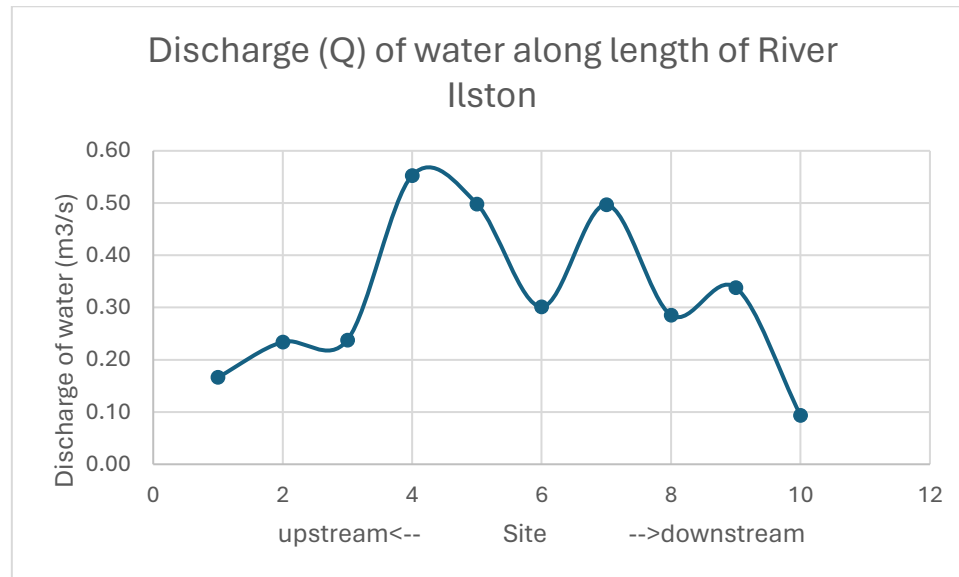


Figure 16. Discharge of water (metres³/second) at 10 consecutive sites along River Ilston

Spearman's correlation between site and discharge	0.09
Pearson's correlation between site and discharge	-0.01

Table 10. Spearman's and Pearson's correlation coefficients for site and discharge (Q) of water

Spearman's and Pearson's correlation coefficients show "very weak" correlation between site and discharge of water which practically refutes hypothesis 8, that the discharge of the river increases downstream.

Conclusion

Conclusion to hypotheses

There was statistically very strong negative correlation between site and bedload size downstream of River Ilston (supporting hypothesis 6). This data is further backed up by the fact that the bedload samples were all sand by Sites 9&10, so couldn't practically be measured in

the field. There was also increased roundness in shape of the representative bedload samples downstream (supporting hypothesis 7).

For all other hypotheses the data was less supportive. The River Ilston became slightly deeper but also slightly narrower downstream, rather than deeper and wider as hypothesis 1 stated. The cross-sectional area slightly decreased downstream, rather than increasing as hypothesis 2 stated. There was very weak negative correlation between velocity and site when using oranges to measure velocity, which only weakly supports hypothesis 5. There was also “very weak” correlation between site and discharge of water along River Ilston, weakly supporting hypothesis 8, that the discharge of river increases downstream.

Research limitations

Pearson’s statistical test requires normally distributed data (normality checks and skewness coefficients were not performed in this study). Since normality was not checked here, Spearman’s statistical test was used as well. However, Spearman’s is useful only if the paired data show a monotonic relationship, i.e. not a quadratic relationship. In a quadratic relationship a coefficient of 0 can be found, but does not mean there is no relationship (this study did not identify whether pairs of data had a quadratic relationship or not).

The study was carried out with data from a one-day fieldtrip, so seasonal or yearly (climatic) variations were not able to be accounted for.

Reflection on how to improve the research

This study could have been improved by performing the study at different seasons as well as over several years to observe how changes in river characteristics are affected.

It would also be improved by studying a ‘control’ river i.e. a similar “misfit” river to compare how this is affected by seasonal changes etc.

Further observations could be included such as how velocity changes depending on the position within the cross-section of the river (ie. Near to the bank vs centre of the river) and by including the meanders in the measurements. Similarly, the study could have been improved by identifying these specific positions where bedload samples were taken from.

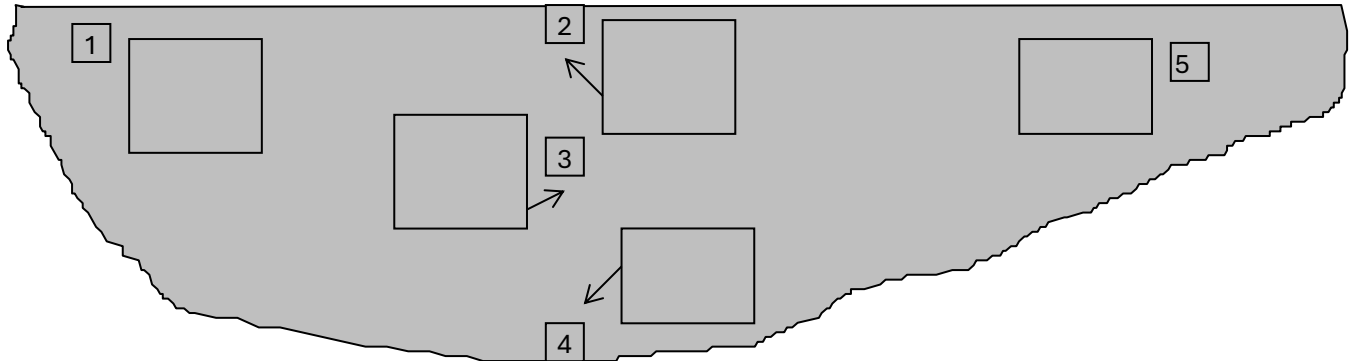


Figure 17. Examples of positions for measuring velocity and/or size/roundness of bedload

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