Aim

To investigate the effects of animal waste on fresh water ecosystems.

Background environmental science

Sewage contains high levels of nitrogen and phosphorus compounds and encourages the growth of plants, which are primary producers (organisms in an ecosystem that produce biomass from inorganic compounds). High levels of nitrogen and phosphorus compounds in water lead to eutrophication, this is when the plants and algae bloom over the water surface and prevent sunlight from reaching other water plants and these plants then die. Bacteria break down the dead plants and use up the oxygen in the water so the body of water won't be able to support life. Sewage entering water sources can also cause contamination and spread diseases such as e-coli, diarrhoea and hepatitis-A.

Biological oxygen demand or BOD is the measurement of dissolved oxygen used by aerobic microorganisms when decomposing organic matter in water. It is an important thing to measure as it is used to show the effect wastewater will have on the environment. The more BOD the more oxygen consuming bacteria will be found. As this is a food source for them, these are the organisms involved in eutrophication.

High levels of suspended solids will also decrease dissolved oxygen levels. Suspended solids are particles larger than 2 thousands of a millimetre (2 microns) found in water and can include inorganic or organic materials. Organic materials in water can include plankton, algae, decaying plants, and animal waste.

Chemical oxygen demand or COD is a measurement of the oxygen required to oxidise soluble and particulate organic matter in water. It is important because along with BOD it is used to show the effect of discharged wastewater on the environment. Higher levels of COD mean that there will be more oxidisable organic matter. This will reduce dissolved oxygen levels and lead to anaerobic conditions which many organisms will not be able to survive in.

Conductivity of water is a measure of the ability of water to pass an electric current. An increase in conductivity can indicate that a discharge or some disturbance has decreased the water quality.

Bioindicators are living organisms such as plants, planktons, animals and microbes. Mayfly larvae are indicators of good quality water, while midge larvae can survive in low oxygen, nutrient rich water.

Combinations of all these parameters can be used to show how healthy an aquatic ecosystem is.

Experimental procedure

Suspended solids were measured using a Hanna water metre. Conductivity was measured using a Hanna water metre. Oxygen concentration was measured using a Lutron dissolved oxygen probe. Aquatic invertebrates were investigated using a dip net.

The equipment was used above and below a field where lots of cows have access to a stream and their waste can cause pollution in the water.

Data

Investigation 1

	Upstream	Downstream
Average Suspended Solids (ppm)	22	37
Average conductivity (µs)	44	72
Average oxygen concentration (mg/l)	15.2	13.5

Percentage change:

Average suspended solids
37 – 22 = 15
15/22 x 100 = 68.18%

Average conductivity
72 – 44 = 28
28/44 x 100 = 63.63%

Average oxygen concentration
15.2 – 13.5 = 1.7
1.7/15.2 x 100 = 11.18%

	Upstream	Downstream	% change
Average suspended solids (ppm)	22	37	68.18
Average conductivity (µs)	44	72	63.63
Average oxygen concentration (mg/l)	15.2	13.5	11.18

Analysis of investigation 1:

There is an increase in suspended solids downstream of the field, suggesting that animal waste is entering the stream and this is supported by the increase in conductivity. The increase in suspended solids can prevent sunlight from reaching submerged plants. This will slow the rate of photosynthesis, which will cause less oxygen to be released into the water source by plants. This could explain why the oxygen concentration decreases at the downstream sample site.

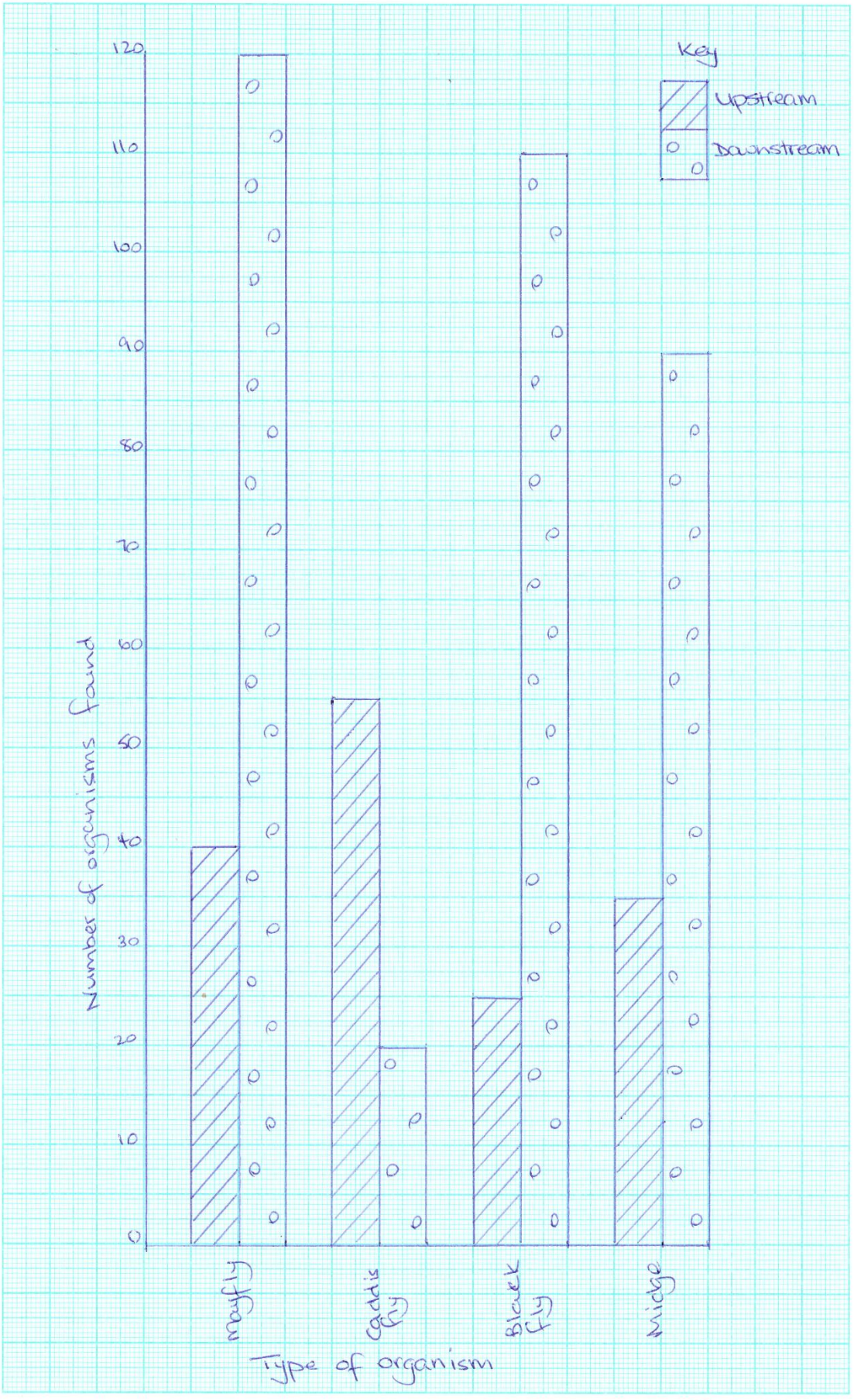
Investigation 2

Organism type	Number of organisms found	
	Upstream	Downstream
Mayfly larvae	40	120
Caddisfly larvae	55	20
Blackfly larvae	25	110
Midge larvae	35	90
Total number	155	340

See graph on next page.

Analysis of investigation 2:

There is a variation in the number of organisms found at each site, with more caddisfly upstream than downstream, but more mayfly, blackfly and midge downstream. Animal waste provides a food source for bacteria and algae, which are organisms that use up dissolved oxygen in the water. Therefore organisms like blackfly and midge that can survive in low oxygen and high nutrient conditions are likely to be found downstream of the pollution. However, many more mayfly were found downstream than upstream which is unusual as they are indicators of good water quality.


Key
Upstream
Downstream
Number of organisms found
0
10
20
30
40
50
60
70
80
90
100
110
120
mayfly
caddis fly
Blackfly
midge
Type of organism
Chartwell Ref. J14B

Conclusion

Both investigations show that animal waste entering a stream can have an impact on abiotic and biotic factors in a fresh water ecosystem, and that this impact is mostly negative. Investigation 1 shows that the animal waste entering the stream affects the oxygen concentration, which then affects which species can best survive there. Investigation 2 shows the types of organisms that have the ability to live in oxygen rich or oxygen poor conditions, with more bioindicators of poorer quality water downstream than upstream.

Evaluation

We took many samples at each sampling point in order to get average results and increase reliability. An improvement would be to sample at more than just two sites as this would further increase reliability.

The data for mayfly at the downstream sampling point was unexpected. Mayfly are bioindicators of good water quality so I would expect there to be less mayfly downstream of the source of pollution than upstream. The investigation would have to be repeated to try to identify if an error had been made.

Animal waste is sewage and can cause disease, so we had to be very careful when sampling not to get the water in our mouths or in any cuts, and to clean our hands carefully with alcohol gel before leaving.

References

1 The effects of sewage on aquatic ecosystems https://sciencing.com/effects-sewage-aquatic-ecosystems-21773.html accessed June 2018

2 Eutrophication http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel/problems_in_environment/pollutionrev4.shtml accessed June 2018

3 Biological oxygen demand (BOD) https://realtechwater.com/parameters/biochemical-oxygen-demand/ accessed June 2018

4 General information on solids http://bcn.boulder.co.us/basin/data/NEW/info/TSS.html accessed June 2018

5 Chemical oxygen demand (COD) https://realtechwater.com/parameters/biochemical-oxygen-demand/ accessed June 2018