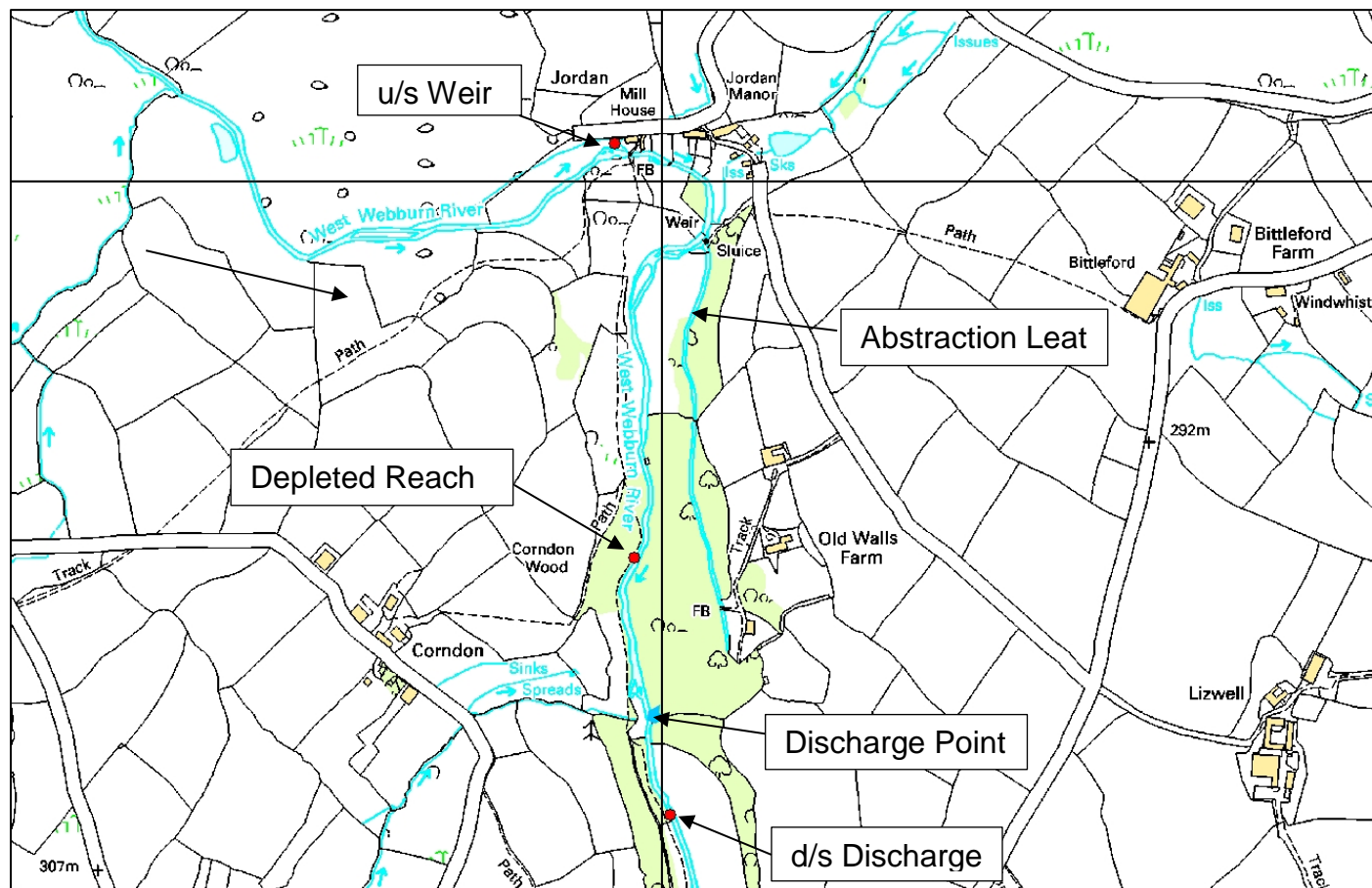


Jordan's Leat (Old Walls Farm) Restoring Sustainable Abstraction Ecology Report 2018

Introduction

Devon Analysis and Reporting Team were requested to assess any ecological impact from Old Walls abstraction using macro invertebrates. Invertebrate samples were taken upstream and downstream of the abstraction weir and downstream of the discharge over two seasons Spring and Summer. The surveys took place at the start and during a prolonged period of dry weather in 2018.

Figure 1. Location Map and site details are shown below



	Watercourse	Site	NGR	Site ID
Site 1	West Webburn	U/S Weir	SX-69948-75042	192351
Site 2	West Webburn	D/S Weir Depleted Reach	SX-69970-74581	192352
Site 3	West Webburn	D/S Discharge	SX-70010-74295	192371

Methodology

At each of the biological survey sites 3 one minute invertebrate samples were collected. This sampling strategy was selected to enable statistical analysis of the results.

The samples were preserved at the laboratory in 100% IDA and analysed to species level where possible.

In addition to the calculation of the Lotic Invertebrate Flow Evaluation (LIFE) scores, the Biological Monitoring Working Party (BMWP) scores and Average Score Per Taxon (ASPT) were also calculated for the samples.

The LIFE method has been designed to relate the invertebrate community of a watercourse to the effects of low flows within river systems. This is a scoring system which is based around recognised flow associations of invertebrates (Extence et al 1999).

The LIFE method works by putting all species within each family into one of six groups which are concerned with flow preference. Each of the six groups has a sliding scale of values according to the abundance within the species.

The values for each of the species found are added together, then these are divided by the number of families found to give the LIFE score. The higher the score, the less effected by low flows the invertebrate community is suggested to be.

A two tailed T- test was performed on the LIFE Scores. T-test is used to analyse two populations through the use of statistical examination; analysts commonly use a t-test with two samples with small sample sizes, testing the difference between the samples when they do not know the variances of two normal distributions.

More statistical analysis was undertaken to look at the community composition of the replicates using the PRIMER (Plymouth Routines in Multivariate Ecological Research) program. The data was transformed by square-rooting all of the abundances to reduce the potential influence of taxa with high abundances and the Bray-Curtis similarities were then calculated. The similarities are plotted on a chart showing the relative proximity to each other. There are no scale units on the chart, it is purely a visual representation. If there is a clear separation between clusters of samples then an impact can potentially be demonstrated. The results of the PRIMER analysis are shown below.

The BMWP, ASPT scores and the number of scoring families are used to relate the invertebrate community in a watercourse to its water quality. The BMWP scoring system works by allocating each family a value between 1 and 10 according to their pollution tolerance. For example, the higher the value, the lower the tolerance is given to be. The allocated values for each of the families found in the sample are added together to give the BMWP score. The higher the final value, the better the water quality is suggested to be for that site.

The ASPT is a further calculation where the BMWP score is divided by the number of scoring families found. Again the higher the score, the better the suggested water quality.

Results and Discussion

ASPT Average Score Per Taxon

All the samples analysed gave good results with average ASPT above 6, whether they were from the upstream weir site, from the depleted reach or the downstream discharge site. This indicates that water quality remained high throughout the spring and summer surveys, even though there was a prolonged dry period between samples being taken.

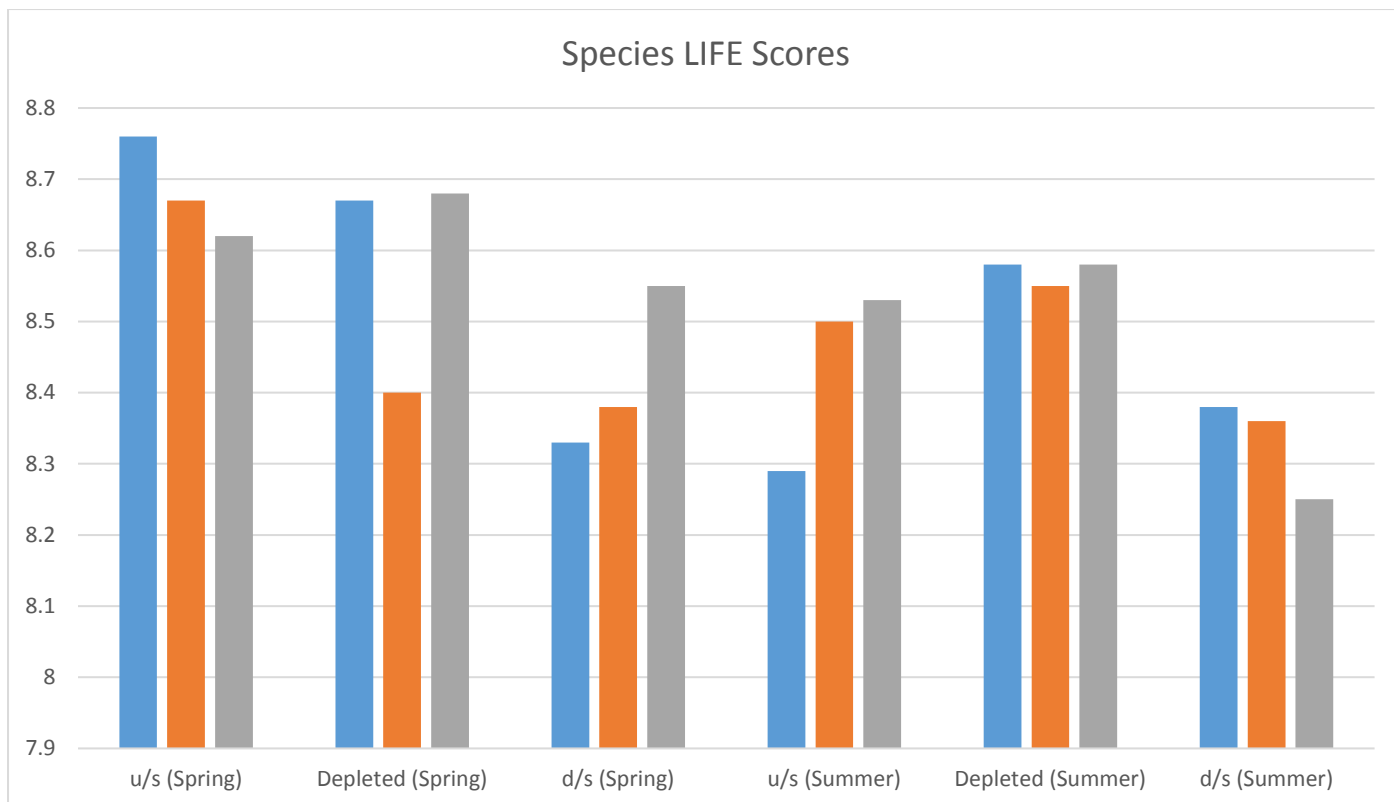
Surveys results for ASPT (average score per taxon) were as expected to confirm that water quality remained good throughout the survey period.

Sample Date	22-May-18	22-May-18	22-May-18
Site ID	192351	192352	192371
Site	1	2	3
Average ASPT	6.60	6.81	6.85

Sample Date	19-Jul-18	19-Jul-18	19-Jul-18
Site ID	192351	192352	192371
Sample ID	1	2	3
Average ASPT	6.24	6.9	6.42

Lotic Invertebrate Flow Evaluation (LIFE) scores

Life scores have been analysed see table below and again they clearly show that we cannot demonstrate any ecological impact downstream of the weir as LIFE scores on average are better downstream of the weir during the summer survey when a deterioration would be expected. The differences shown in the graph are marginal and scores of 8 or above at all sites indicate good ecological habitat throughout survey reach.



T Tests

Invertebrate results were run through a T Test which are shown below and again no ecological impact can be detected downstream of the weir. This is due to the fact the results are so similar.

t-Test: Two-Sample Assuming Equal Variances

	<i>u/s(Spring)</i>	<i>Depleted(Spring)</i>
Mean	8.683333333	8.583333333
Variance	0.005033333	0.025233333
Observations	3	3
Pooled Variance	0.015133333	
Hypothesized Mean Difference	0	
Df	4	
t Stat	0.995584967	
P(T<=t) one-tail	0.187900319	
t Critical one-tail	2.131846786	
P(T<=t) two-tail	0.375800637	
t Critical two-tail	2.776445105	

t-Test: Two-Sample Assuming Equal Variances

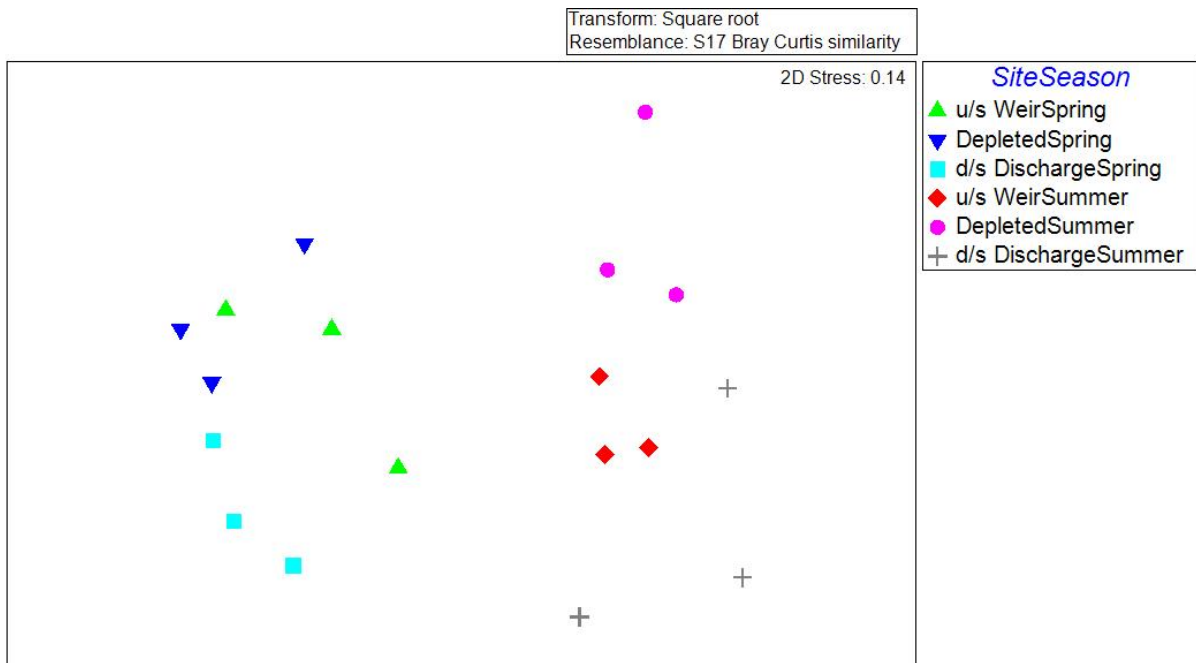
	<i>u/s(Spring)</i>	<i>d/s(Spring)</i>
Mean	8.683333333	8.42
Variance	0.005033333	0.0133
Observations	3	3
Pooled Variance	0.009166667	
Hypothesized Mean Difference	0	
Df	4	
t Stat	3.368571318	
P(T<=t) one-tail	0.014040428	
t Critical one-tail	2.131846786	
P(T<=t) two-tail	0.028080856	
t Critical two-tail	2.776445105	

t-Test: Two-Sample Assuming Equal Variances

	<i>u/s(Summer)</i>	<i>Depleted(Summer)</i>
Mean	8.44	8.57
Variance	0.0171	0.0003
Observations	3	3
Pooled Variance	0.0087	
Hypothesized Mean Difference	0	
Df	4	
t Stat	1.706983627	
P(T<=t) one-tail	0.081507826	
t Critical one-tail	2.131846786	
P(T<=t) two-tail	0.163015652	
t Critical two-tail	2.776445105	

PRIMER (Plymouth Routines in Multivariate Ecological Research)

Primer analysis show that the 3 replicates are very similar for each site. The differences shown in the diagram below are relatively small and cannot be explained by changes in flow downstream of the weir but they do show a variation between spring and summer samples.



Photos

During the surveys lots of photos were taken and these best show the character of the river.

Below are a sample of the photos taken in spring 2018

Photo showing upstream weir invertebrate site in spring 2018



Photo showing weir rim and abstraction leat entrance spring 2018



Photo showing weir with fish pass spring2018



Photo showing leat by wash channel returning to the West Webburn in spring 2018



Photo showing depleted site location spring 2018



Photo showing discharge point from Turbine/Generator House spring 2018



Photo showing invertebrate site downstream discharge point spring 2018



Below are a sample of the photos taken in the summer 2018

Photo showing upstream weir invertebrate site in summer 2018



Photo showing weir with fish pass summer 2018



Photo showing weir rim and abstraction leat entrance summer 2018



Photo showing sluice gate summer 2018



Photo showing leat by wash channel returning to the West Webburn with no flow in summer 2018



Photo showing depleted site location summer 2018



Photo showing fish return pipe which comes down from the leaf summer 2018



Photo showing discharge point from Turbine/Generator House



Photo showing invertebrate site downstream discharge point summer 2018



Conclusions

The invertebrate survey data has been put through various tests but none have shown an ecological impact caused by the abstraction for Jordan's Leat Mill.

Water quality remained high at all times during the survey period.

The depleted stretch showed no signs of deterioration and the volume of water remained high even after a prolonged period of dry weather.

The weir, leat and structures all looked to be well maintained, the only improvement to recommend is a screen at the beginning of the leat to stop fish ingress into the leat.

References

Extence C. A, Balbi D. M & Chadd R. P (1999). River Flow Indexing Using British Benthic Macroinvertebrates: A Framework for Setting Hydroecological Objectives. Regul. Rivers: Res. Mgmt. 15 543-574.

PRIMER <https://www.primer-e.com/>