

Vaki Riverwatcher Turbidity Trials

Overall objective

To determine the relationship between turbidity and Vaki Riverwatcher detection efficiency.

Introduction

Vaki Riverwatcher fish counters consist of two plates, 10-45cm apart, each containing opposing rows of infrared LED lights and receivers. Objects passing through the counter break the infrared light beams and generate a silhouette image. These counters are most commonly used in the UK to monitor fish passes and are usually located in the exit of Denil or Larinier passes. Where the fish pass exit is too wide to accommodate the scanner plates, an inscale is used to guide fish through the counter.

Infrared light is rapidly attenuated in water and a high sediment load in a river will serve to increase this attenuation. Rivers in lowland areas of the UK are often highly turbid during spate conditions. It is therefore important to know the turbidity limits for the effective operation of Riverwatcher counters, especially where a full count of fish is required or when the effect of river flow on fish use of the pass is being investigated.

Methods

Response measured: detection/no detection

Independent variables:

Turbidity
Fish size

The Vaki Riverwatcher counter was set-up in a 2m² tank (Figure 1 & Appendix 1) at Cynrig Fish Culture Unit, near Brecon. Weighted wooden 'fish' targets were suspended on thin cord and pulled through the counter's scanner plates using braided line and pulley wheels (Figure 2 and Figure 3). The scanner plates were set at a standard width of 35cm apart using the cassette originally supplied with the counter.

Three different dummy fish sizes (based on a length:depth ratio of 6:1) were used:
300mm long (50mm deep)
480mm long (80mm deep)
720mm long (120mm deep).

Sediment was added to the water until the desired turbidity was achieved (measured in Nephelometric Turbidity Units, or NTU, using a YSI turbidity probe) and the water was mixed using paddles to ensure that the sediment was kept in suspension (Figure 4).

Other variables (swimming speed, passage rate and swimming position) were considered but were discounted as they were not thought to have a significant effect.



Figure 1: Vaki Riverwatcher fish counter experimental arrangement.



Figure 2: Fish and pulley wheel system.



Figure 3: Vaki Riverwatcher counter, turbidity probe and fish target under clear conditions (0 NTU).



Figure 4: Experimental conditions following the addition of sediment to the water.

Preliminary work

Aim: To identify the approximate turbidity value(s) where detection rates begin to decrease.

In order to establish a baseline efficiency estimate, each of the dummy fish was passed through the scanner plates 50 times before any sediment was added and the number of detections (up and down) was recorded. The speed of passage was kept as constant as possible. Turbidity was recorded, the data were downloaded and the counter reset.

Sediment deposited in the outlet from one of the fish culture unit tanks was collected and added to the water to increase the turbidity. The procedure detailed above was repeated, using only the smallest and medium sized dummy targets, at gradually increasing turbidity increments until counter efficiency fell below the baseline estimate. The largest dummy target was not used as, due to limited tank size, it was difficult to ensure that the target passed all of the way through the counter.

Main experiment

Aim: To quantify the effect of turbidity on Riverwatcher detection rates.

The turbidity values around which detection efficiency began to decrease, identified from the preliminary work, were examined in more detail. The target was passed through the scanner plates once; the turbidity at that time was recorded as well as whether or not it was detected by the counter. Only the smallest and medium sized dummy targets were used. Sediment was added as required. This procedure was repeated numerous times for both target sizes over a narrow range of turbidities.

Minitab's logistic regression function was used to analyse the data.

Results

The baseline efficiencies (at 0 NTU) for all 3 dummy target sizes were 100% (Table 1). Preliminary trial results indicated that detection efficiencies began to drop below 100% between 66 and 88 NTU (Table 1).

Table 1: Preliminary trial results

<i>Turbidity</i>	<i>Fish size</i>	<i>No of passes</i>	<i>Detection efficiency (%)</i>
0	S	50	100
0	M	50	100
0	L	50	100
10-15	S	50	100
40-45	S	50	100
66-88	M	109	86
103-133	M	50	0
121-127	S	50	0

A logistic regression model, using data from the main experiment, shows that the probability of detection drops below 0.9 at 90 NTU (Figure 5 & Appendix 2). It then drops very rapidly to less than 0.01 at 101 NTU (Figure 5).

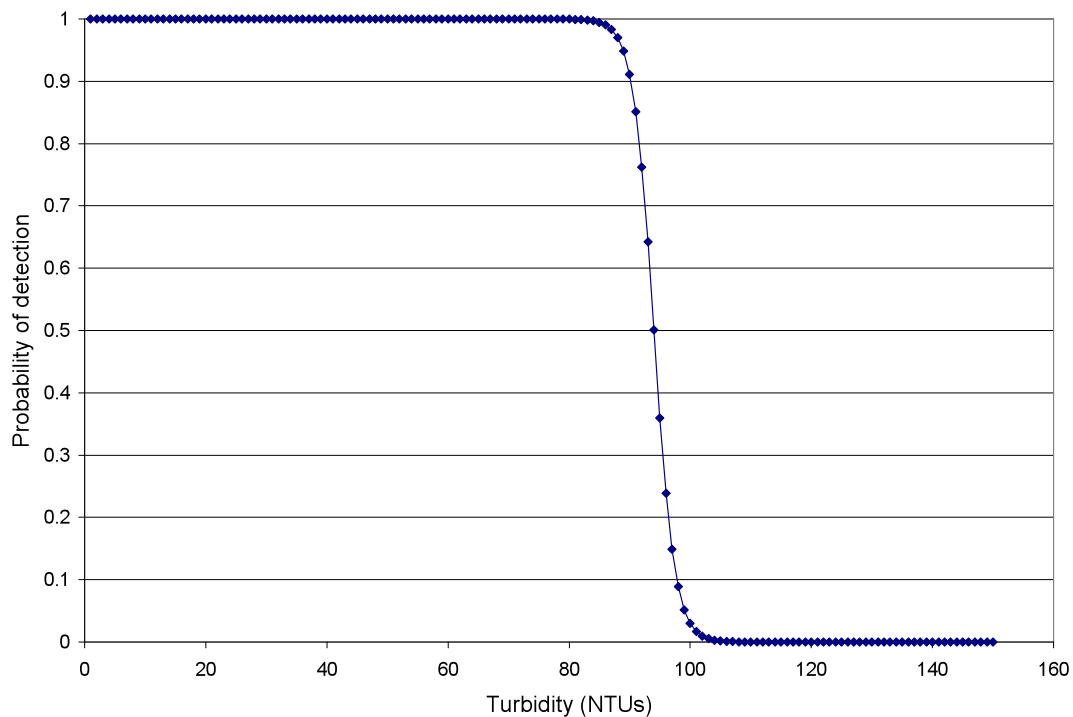


Figure 5: Logistic regression model for probability of detection and turbidity

Discussion and further work

These results demonstrate that the Riverwatcher counter ceases to work at turbidities greater than 100 NTU and that efficiencies drop below 90% at 90 NTU. This may not be important if the function of the counter is to provide a measure of fish pass effectiveness or to provide evidence that fish use the pass. It could become an issue at some sites, however, if a full count is required or if the data are to be used to examine the effects of environmental factors on fish use of the pass.

For these sites it is recommended that the following investigations are carried out:

- Establish the frequency and proportion of time that the river exceeds 90 NTU.
- Determine (where possible) whether, and what proportion of, fish use the pass during turbid conditions. This could be achieved using a DIDSON acoustic counter.

Appendices

Appendix 1: Riverwatcher counter settings

<i>Setting</i>	<i>Value</i>
Minimum	30
Garbage threshold	25
Position	0

Appendix 2: Logistic regression output from Minitab

Binary Logistic Regression: Detected versus Turbidity

Link Function: Logit

Response Information

Variable	Value	Count	
Detected	Yes	265	(Event)
	No	114	
Total		379	

Logistic Regression Table

Predictor	Coef	SE Coef	Z	P	Odds Ratio	95% CI Lower	95% CI Upper
Constant	54.6668	7.23582	7.56	0.000			
Turbidity	-0.581535	0.0770728	-7.55	0.000	0.56	0.48	0.65

Log-Likelihood = -59.233

Test that all slopes are zero: G = 345.076, DF = 1, P-Value = 0.000

Goodness-of-Fit Tests

Method	Chi-Square	DF	P
Pearson	109.744	194	1.000
Deviance	87.601	194	1.000
Hosmer-Lemeshow	6.830	6	0.337
Brown:			
General Alternative	3.095	2	0.213
Symmetric Alternative	0.017	1	0.896

Table of Observed and Expected Frequencies:

(See Hosmer-Lemeshow Test for the Pearson Chi-Square Statistic)

Value	Group								Total
	1	2	3	4	5	6	7	8	
Yes									
Obs	1	2	10	26	36	39	37	114	265
Exp	0.2	1.9	9.7	28.9	34.7	38.7	37.0	114.0	
No									
Obs	38	35	27	13	1	0	0	0	114
Exp	38.8	35.1	27.3	10.1	2.3	0.3	0.0	0.0	
Total	39	37	37	39	37	39	37	114	379

Measures of Association:

(Between the Response Variable and Predicted Probabilities)

Pairs	Number	Percent	Summary Measures	
Concordant	29682	98.3	Somers' D	0.97
Discordant	509	1.7	Goodman-Kruskal Gamma	0.97
Ties	19	0.1	Kendall's Tau-a	0.41
Total	30210	100.0		