

# The effect of `liming` as a technique to mitigate acidification upon the macro-invertebrates of the river Fleet catchment, Galloway Scotland.

## Abstract

The Water of Fleet, Galloway, Scotland has suffered heavy acidification through anthropogenic acid deposition, exacerbated by local conifer forestry. In 2011, 2012 & 2015 the Galloway Fisheries Trust (GFT) used two forms of liming to mitigate the effects of acidification. In order to assess the effect of this restoration technique, two of the limed watercourses were compared to four un-limed watercourses in terms of macroinvertebrate community structure, presence of acid sensitive species and biotic indices values. Liming had an overall positive effect upon treated watercourses with elevated macroinvertebrate species abundance, richness, evenness and diversity as well as higher biotic indices values.

## 1 Introduction

Numerous river catchments in the UK that lie upon poorly buffered natural geology have become acidified, due to anthropogenic acid deposition.

In catchments such as the Water of Fleet, this effect has been exacerbated by local coniferous forestry, resulting in a classification of "bad" according to Water Framework Directive (WFD) assessments upon aquatic animal populations [1].

Acidification and the corresponding effects of mobilised aluminium have been reported to have a profound impact upon the biodiversity of fresh-water ecosystems, with detrimental effects recorded at every trophic level in riverine food webs [2].

The sensitivity of macroinvertebrates to acidification is well documented, often affecting the species present, their abundance, richness, evenness and diversity, commonly resulting in the loss of sensitive groups [3].

## 3 Hypotheses

$H^0$  – Liming has not led to an increase in acid sensitive macroinvertebrate species as opposed to un-limed control watercourses.  $H^1$  – Liming has resulted in the increase of acid sensitive macroinvertebrate species when compared to un-limed watercourses.  $H^{0-1}$  – No positive effects of liming upon the macroinvertebrate community structure (abundance, richness, evenness & diversity) in comparison to un-limed watercourses.  $H^{1-1}$  – Liming has resulted in a positive impact in macroinvertebrate community structure in terms of abundance, richness, evenness and diversity, as opposed to watercourses that had not received the treatment.  $H^{0-2}$  – No positive effect was found in terms of biotic indices scores of limed watercourses as opposed to watercourses that had not received the treatment.  $H^{1-2}$  – Liming resulted in a positive effect in terms of the values denoted by biotic indices in comparison to un-limed watercourses.

## 5 Results

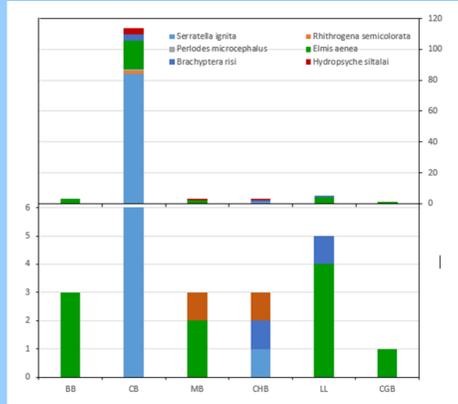


Figure 1, illustrating the acid sensitive taxa found, the first two watercourses labelled BB and CB were limed, however the CB contained the vast majority of acid sensitive macroinvertebrates.

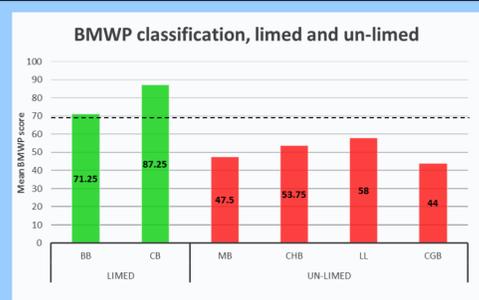


Figure 2, shows the average BMWP score of the watercourses compared to the Scottish River Classification Scheme classifications.

Burn	Site			
	1	2	3	4
Benmeal burn (L)	Poor	Poor	Poor	Poor
Cardoon burn (L)	Poor	Poor	Moderate	Moderate
Mid burn	Bad	Bad	Moderate	Poor
Carrouch burn	Poor	Bad	Poor	Bad
Lane of the loop	Poor	Moderate	Bad	Poor
Craiglowrie burn	Bad	Bad	Bad	Bad

Figure 3, Illustrates the results of the Acid Water Indicator Community (AWICsp) Scottish EQR status classes, note very little variation in the limed watercourses denoted with (L).

## 2 Mitigation of Acidification

Despite efforts to reduce industrial emissions, natural biological recovery has been slow. In the interim, the most effective short term remedy has been "liming" or the widespread addition of calcium carbonate to watercourses (2).

Two forms of catchment liming were implemented by the Galloway Fisheries Trust (GFT) in 2011, 2012 and 2015, the run-off from which entered two of the primary tributaries of the Water of Fleet, the Benmeal burn (BB) and Cardoon burn (CB).

The effect of the liming upon the macroinvertebrate community was assessed by comparing the two limed watercourses with four un-limed watercourses (MB, CHB, LL & CGB) of the same catchment in terms of macroinvertebrate taxonomic composition, the presence of acid sensitive species, biotic indices, biological diversity and total abundance.

## 4 Method

- Macroinvertebrates were collected from six watercourses, two of which were limed.
- Sampling consisted of a standard three minute kick sample and a minute manual search following the RivPacs (2004) protocol [4].
- Macroinvertebrates were preserved and later identified to species taxonomic level.

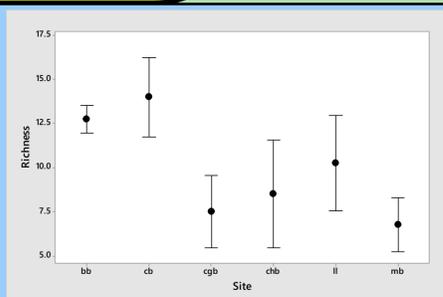


Figure 4, shows a significant difference in species richness between limed and un-limed watercourses.

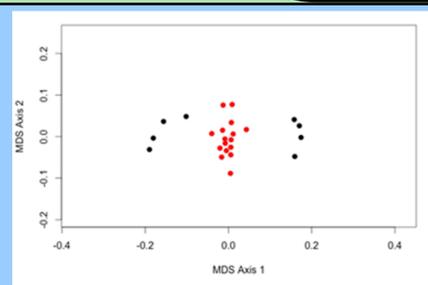


Figure 5, the results of multivariate analysis, PERMANOVA. No significant difference was found between limed and un-limed watercourses. Courtesy Dr. Nicholas Beavers.

## 6 Discussion

The primary findings of this project include: the presence of acid sensitive macroinvertebrates within the limed CB primarily of the species: *Serratella ignita*, *Rhithrogena semicolorata* and *Perlodes microcephalus* which are typically absent below a pH of 6 [5], shown in figure 1. Other findings showed considerably higher BMWP scores in limed burns when compared to controls, as depicted in figure 2. In terms of AWICsp and status classes denoted, although none were above the `moderate` or the pass boundary of the WFD, limed watercourses tended to be more balanced and with higher scores as depicted in figure 3. Liming had an impact on taxon richness which increased significantly, figure 4. Multivariate analysis, figure 5, although not significant showed variation in diversity of limed sites that may have been significant had more samples been collected.

## 7 Conclusion

This study gives evidence that liming upon the Water of Fleet catchment has had an overall positive impact upon the localised macroinvertebrate community, giving insight on the efficacy of this restoration technique upon the ecosystem, as macroinvertebrates play an important role in the food chain.

In response to the aforementioned hypotheses: The null hypotheses ( $H_0$ ) was accepted as acid sensitive species increased at only one treated watercourse. The null hypotheses ( $H_0-1$ ) was rejected as liming resulted in a positive impact in macroinvertebrate community structure in terms of abundance, richness, evenness and diversity. The null hypotheses ( $H_0-2$ ) was rejected as liming resulted in a positive effect in terms of the values denoted by biotic indices in comparison to un-limed watercourses.

## References

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