Stream Restoration: Getting the Microbial Ecology Right

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Stream Restoration

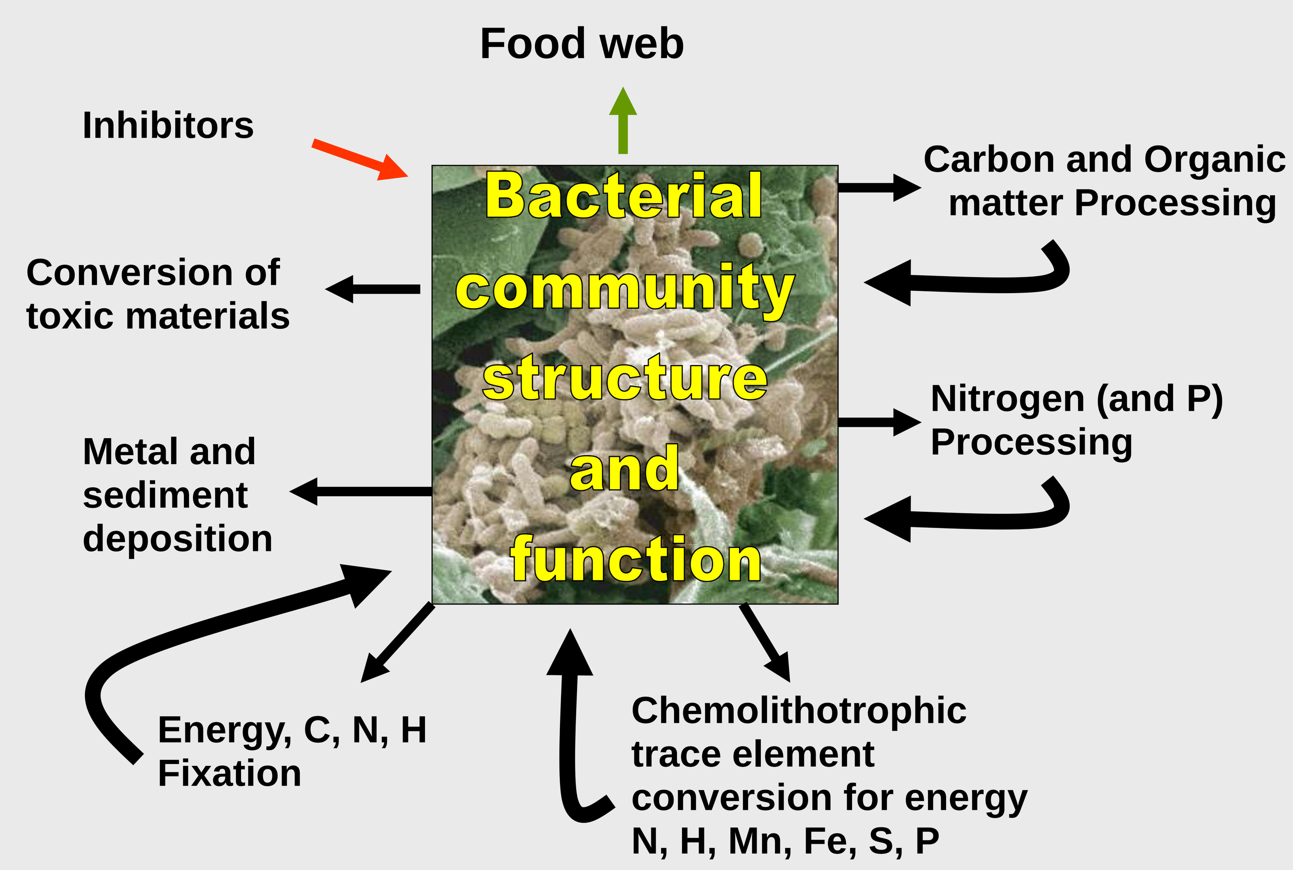
A comprehensive program to re-establish the structure and function of an ecosystem, including its natural diversity and aquatic habitats.

Restoration activities are focussed on macro ecosystem components such as riparian plants, macrobenthic invertebrates and fish. Efforts are directed to enhancing "natural" stream form and native bank side vegetation to provide insect and bird habitat, to shade and cool the water and to reduce erosion. Instream habitat may be improved by adding woody debris, rocks, gravel and sand.

Water flow variability may be managed and water quality improved at specific point sources such as drains. Restoration often involves community projects with a high level of support from enthusiastic individuals.

Role of Biofilm Bacteria in Stream Ecosystems

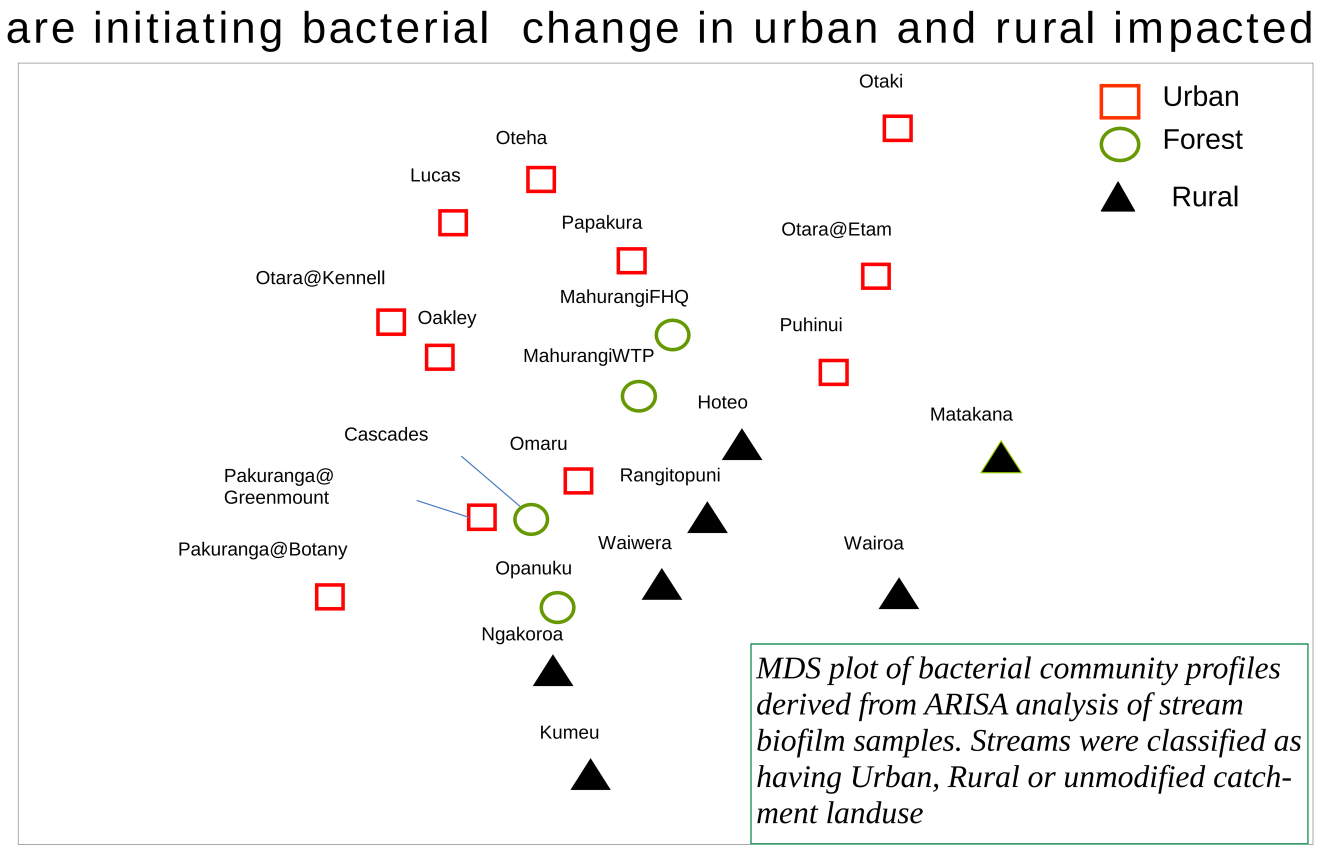
Bacteria are critical components of stream food webs through fixation and conversion of energy, carbon and nutrients and as a food source to other trophic levels. Biofilm bacterial populations respond to changes in condition and might be expected to be changed by enrichment and by contaminants.



Stream Modification and Contamination Effects on Bacterial Population Structure.

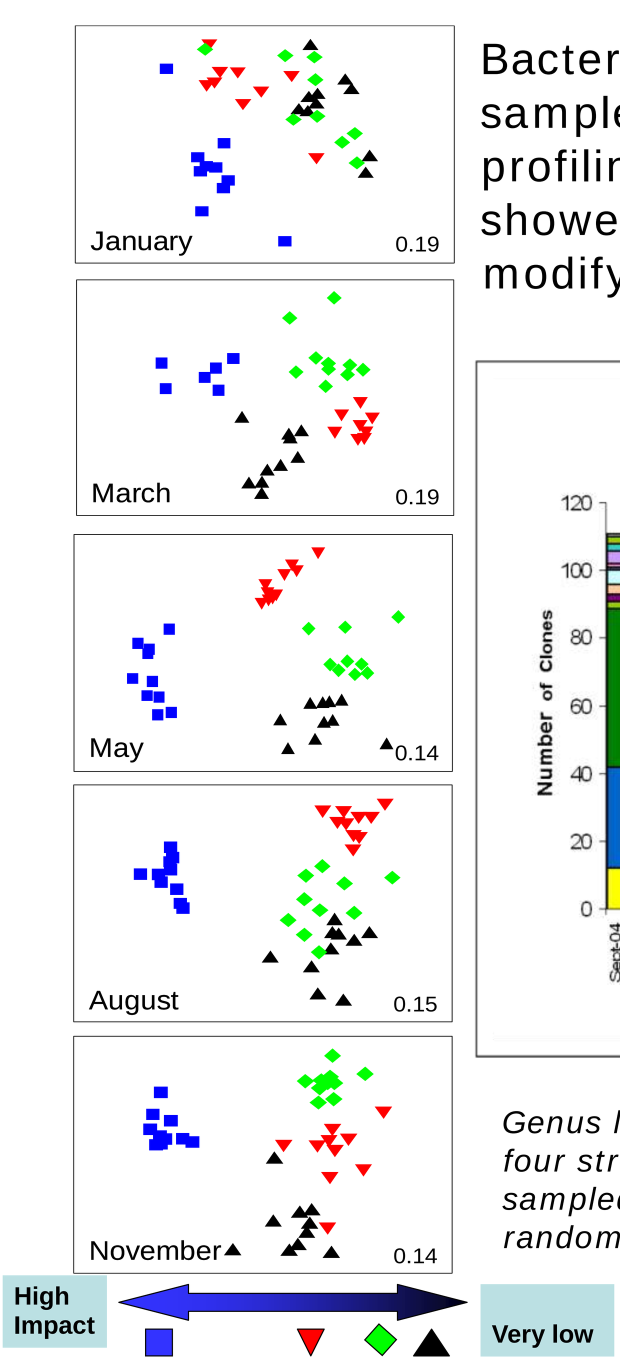
Landuse

Different landuses give rise to different broad groupings of bacterial populations based on ARISA (Automated Ribosomal Intergenic Spacer Analysis) of biofilm samples collected over a 7 day period. The trends shown in the MDS plot below suggest different pressures are initiating bacterial change in urban and rural impacted streams.



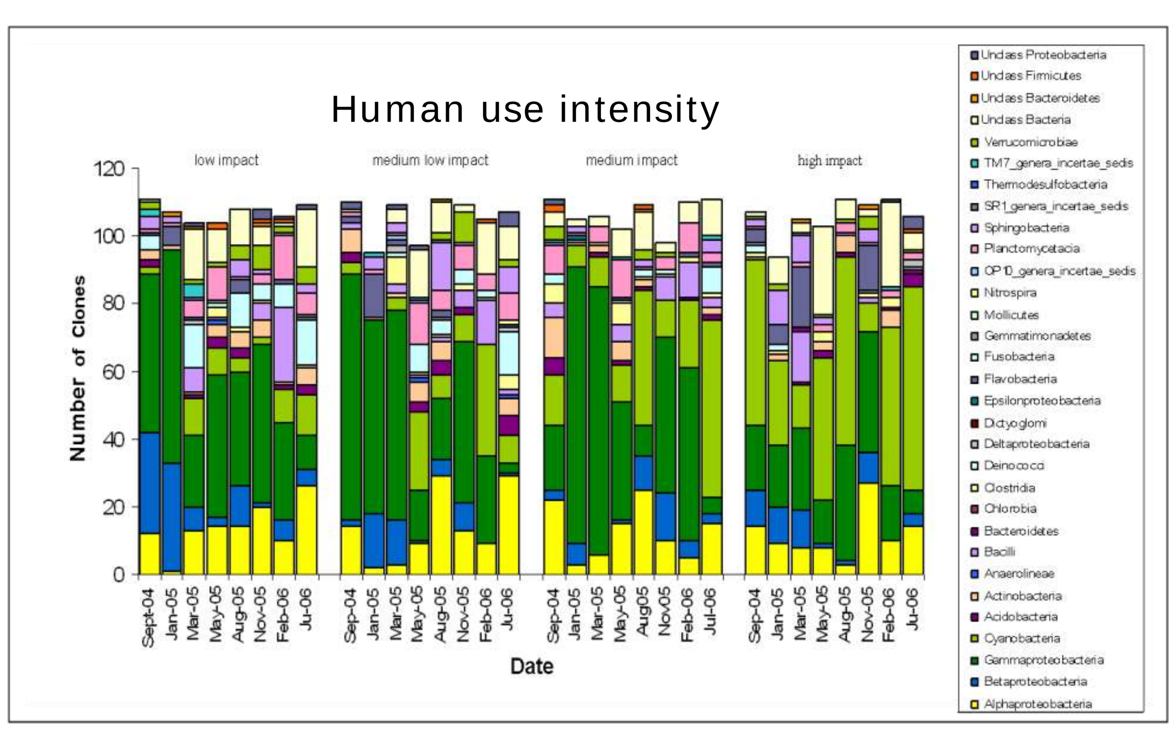
MDS plot of bacterial community profiles derived from ARISA analysis of stream biofilm samples. Streams were classified as having Urban, Rural or unmodified catchment landuse

Time and Human Impact



MDS plots of stream biofilm data for four different streams by season

Bacterial analysis of biofilms from four streams sampled seasonally and analysed by community profiling (ARISA) and sequencing of 16S rDNA showed that both time and human use intensity modify the bacterial population.

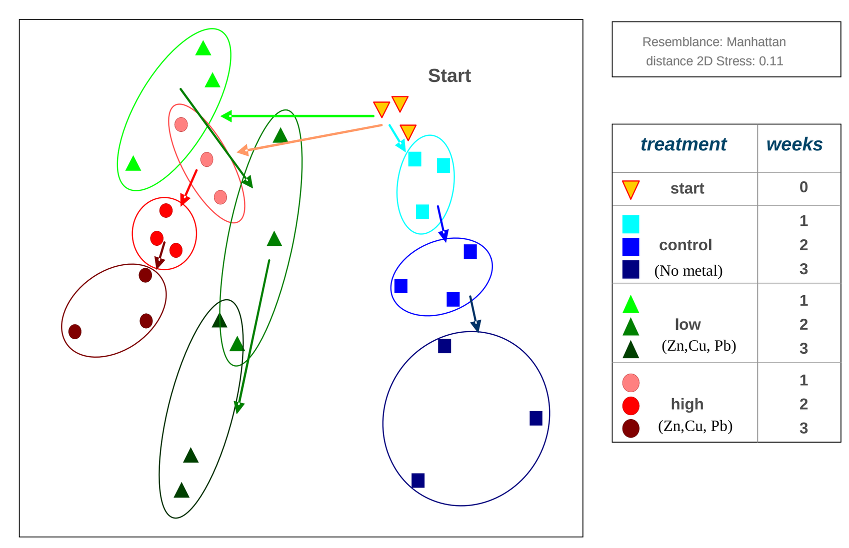


Genus level bacterial population data for bacterial biofilms from four streams with different levels of human impact. Biofilms were sampled seasonally and 16S rDNA sequencing carried out on 100 randomly sampled cloned PCR fragments per sample.

Modifying Effects of Heavy Metals and Nutrients

The rural and urban data shown suggests that nutrient enrichment in rural streams and inhibitors in urban streams may be major effectors of bacterial community composition.

Heavy metals have been shown by our work to significantly modify bacterial community composition. Nitrogen, ammonia and dissolved oxygen have also been shown to account for significant change in bacterial community profiles (see posters 77 and 212).



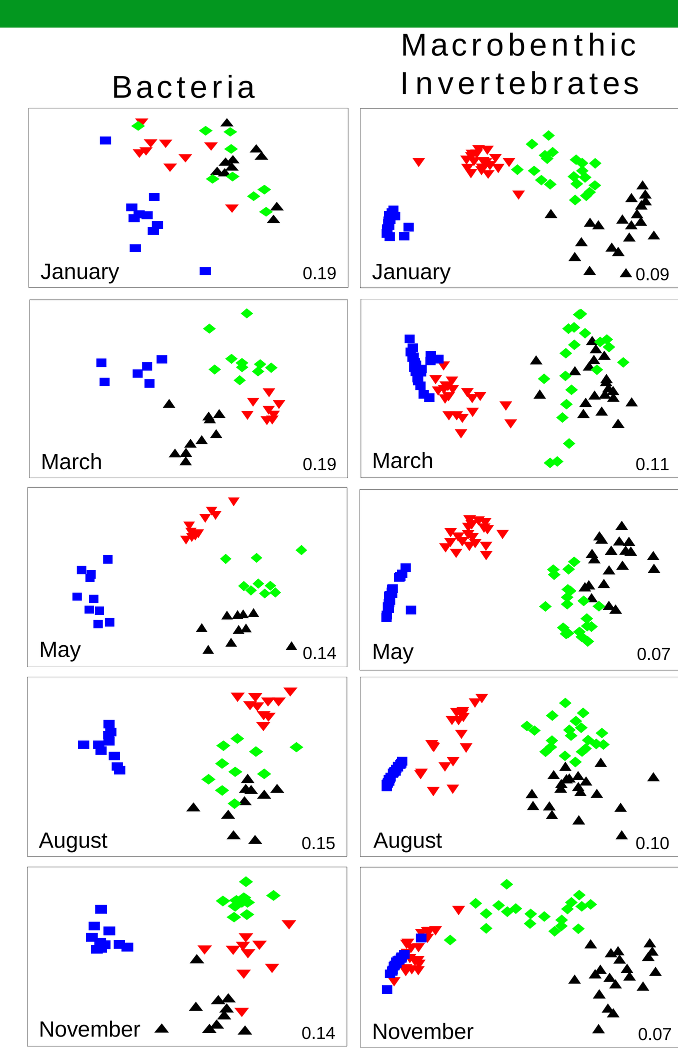
Six week old stream biofilms grown in a laboratory flow system were exposed to the zinc, copper and lead at a similar level to stormwater (low) or 10 x storm water (high) concentrations. Bacterial population profiles were assessed after 1,2 and 3 weeks exposure using ARISA (see poster 292)

Will 'Classical' Stream Restoration Approaches Enhance Aquatic Microbial Ecology?

Effectiveness of classical restoration techniques is judged on the response of macrobenthic invertebrates and fish. Where restoration has been unsuccessful it is often because toxic materials such as metals remain in the stream or inputs of these are not reduced (for example restorations where planting and stream bed modification occurs but urban storm water is not treated and is toxic)

Our data (right) suggests that factors which degrade or enhance macrobenthic invertebrate diversity also effect bacterial community profiles. Restoration procedures that reduce the level of contaminating metals and nutrients should work well in restoring bacterial communities.

The answer — YES!



Bacteria and macrobenthic invertebrate population in 4 streams over a year. Note that the population distributions within the MDS plot comparing diversity and abundance indicate that similar drivers may be acting on both bacterial and macrobenthic invertebrate communities.

References:

Lear, G., Turner, S., Lewis, GD. Effect Of Light Regimes On The Utilisation Of An Exogenous Carbon Source By Freshwater Biofilm Bacterial Communities, Aquatic Ecology (*Accepted for Publication*)

Lear, G., Anderson M.J., Smith J.P., Boxen K., Lewis, GD (2008) Spatial and Temporal Heterogeneity of the Bacterial Communities in Stream Epilithic Biofilms. FEMS Microbiology Ecology 65 (3) 463-473.

Acknowledgements

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