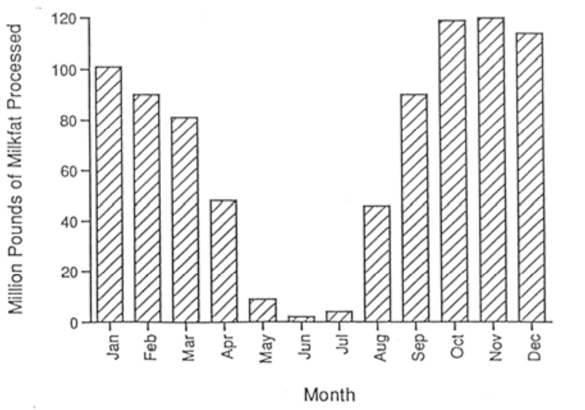
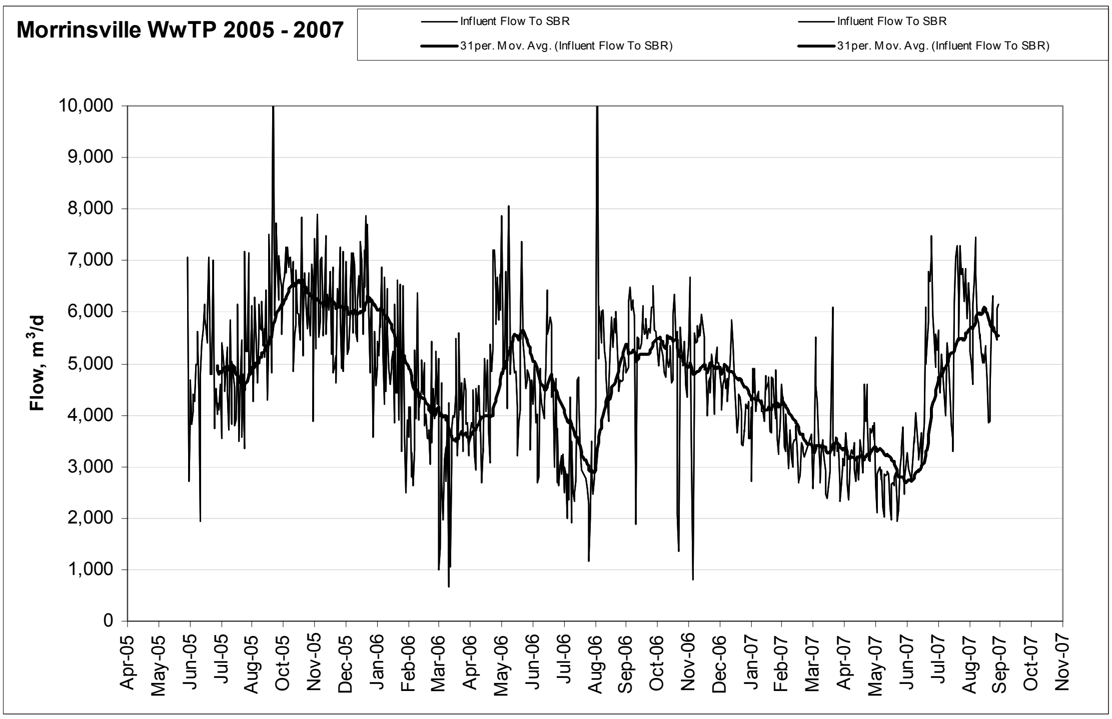
Seasonal Impact of Dairy Factory Effluent on an SBR treatment plant. **Liz Millan**

The seasonal impact of dairy factory effluent, on the wastewater treatment plant receiving it, has been studied over several years. The SBR type WWTP receives stable quantities and strengths of predominantly domestic sewage, from the surrounding community, year around. In addition seasonally fluctuating loads of factory waste are received. The dairy factory waste can increase the daily organic loading many-fold due to its high strength, disproportionate to its impact on plant flow.

http://www.livestocktrail.uiuc.edu/dairynet/paperDisplay.cfm?contentID=258

Figure 1. Seasonal variation for milkfat processing in New Zealand 1992.

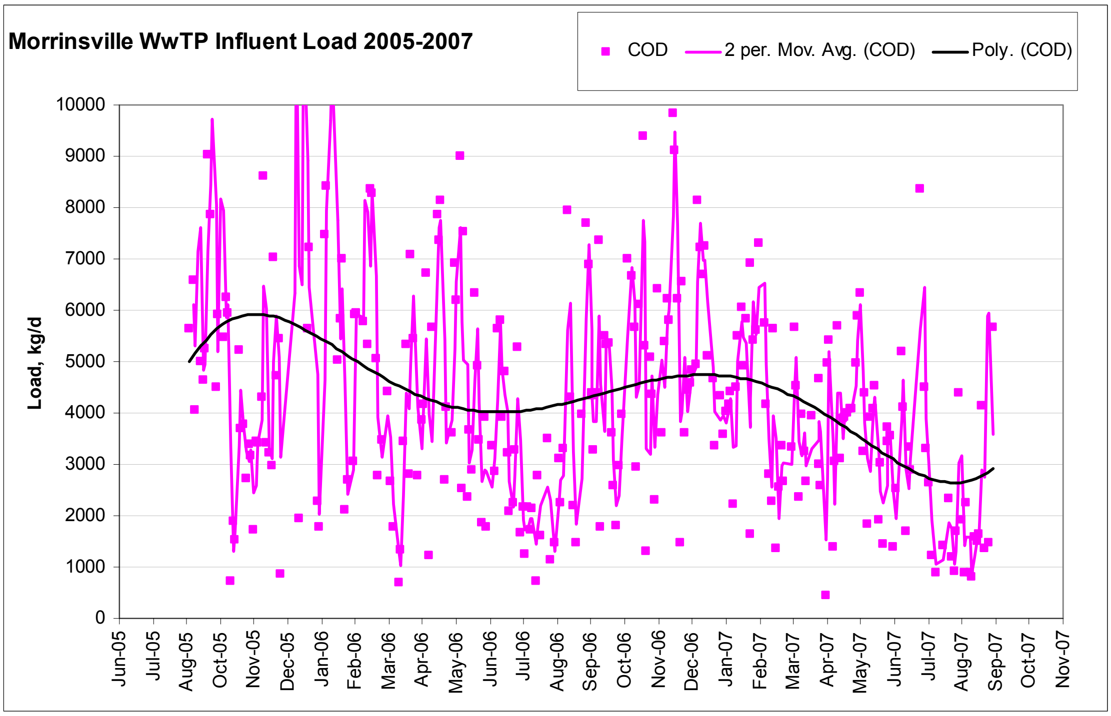




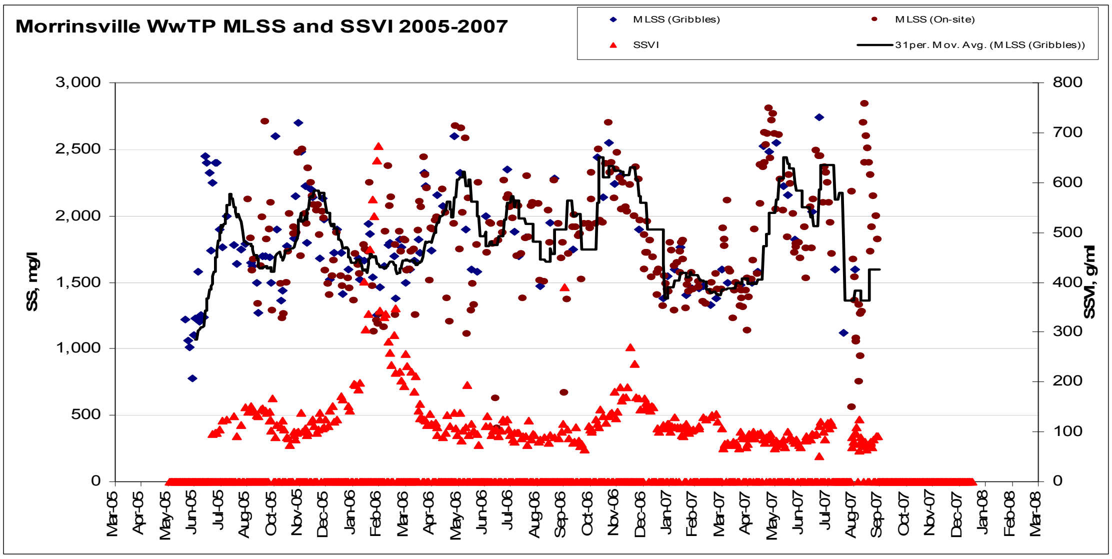
The impact of seasonal factory activities on the influent received has been quantified, along with gauging the effect on the treatment plant biomass feeding upon it. Complementing on-site chemical parameter testing, regular (fortnightly / monthly) samples were referred for microscopic examination by Liz Millan of Scope Global Ltd. The goal was to identify and record characteristics such as floc structure (and effect on settling ability), protozoa and metazoan presence – with relative numbers, also identify and roughly quantify filamentous bacteria comprising the floc backbone. Research and review of these micro-organisms' key selection factors could then be compared to influent data and operational trends.

Frequent on-site monitoring of mixed liquor suspended solids and stirred settlability testing (yielding SSVI), tracking of sludge age and Food/Mass ratio were considered to see if they were impacted by influent changes and/or showed relationships to floc constituents or treatment efficiency.

Loadings are closely related to the activities of the factory. Chart below shows trendlines more clearly with reformatted scale excluding the extreme outliers.



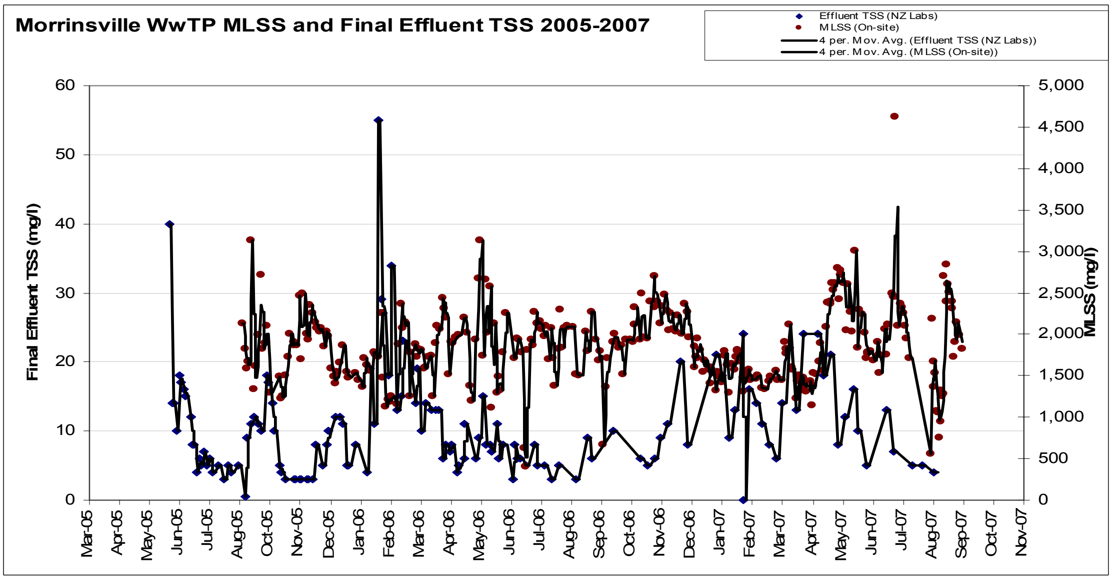
In an attempt to maintain more stable F/M ratios throughout the seasons, the treatment plant has been operated with increased MLSS (mixed liquor suspended solids = available "bugs") during the peak loads.



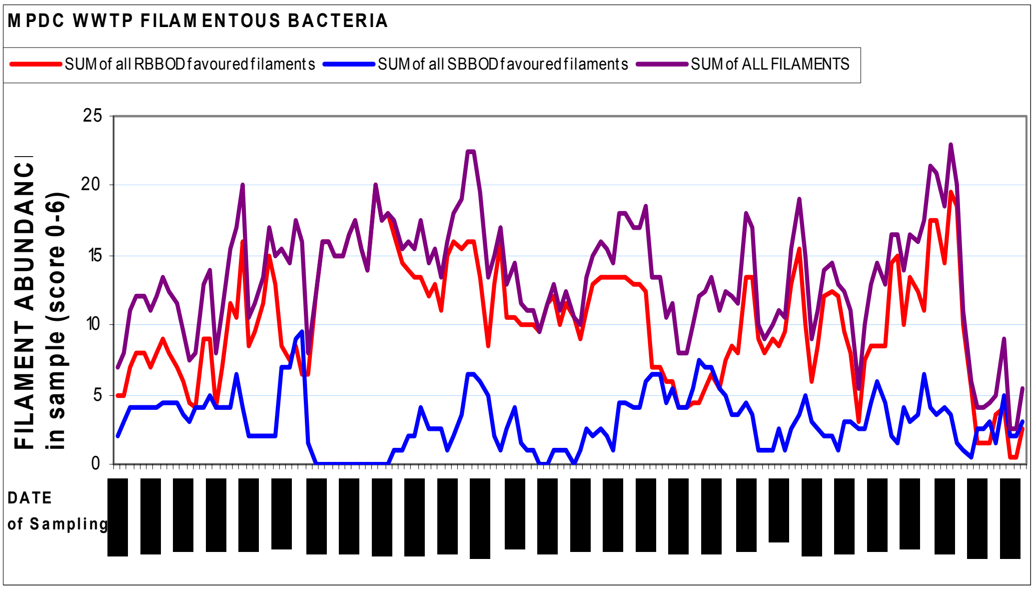
It is noticeable that stirred sludge volume index (SSVI being the settlable solids divided by the MLSS values) are highest around December-January of each year, coinciding with the peak loads. It is when the plant is under highest organic loading (due to factory activities) that sludge settlability is at its poorest.

This was not a good predictor of effluent quality however. Effluent BOD was almost never above 20 g/m^3 no matter what the organic loading or time of year.

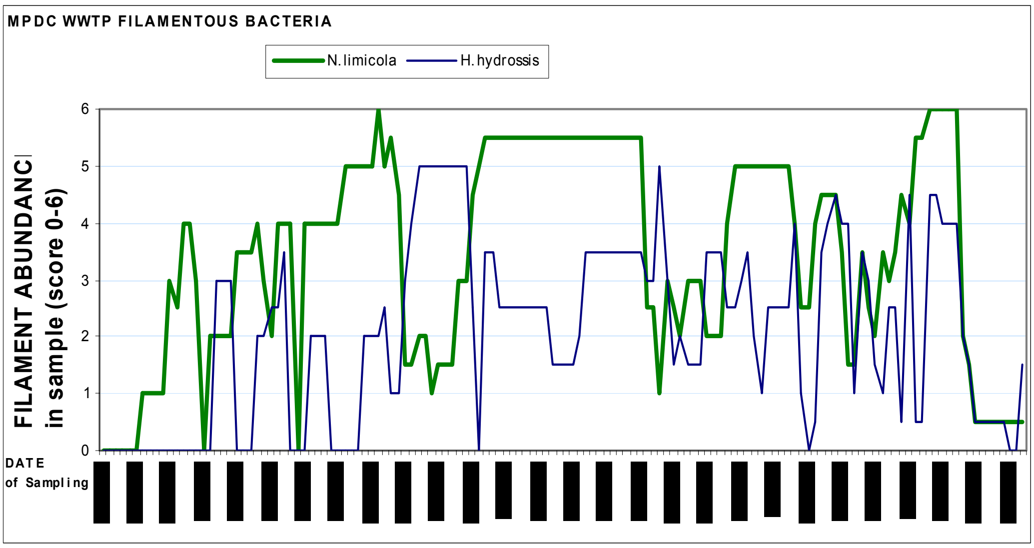
No clear relationship could be identified between MLSS (& hence sludge age to an extent) and effluent quality in terms of suspended solids levels.

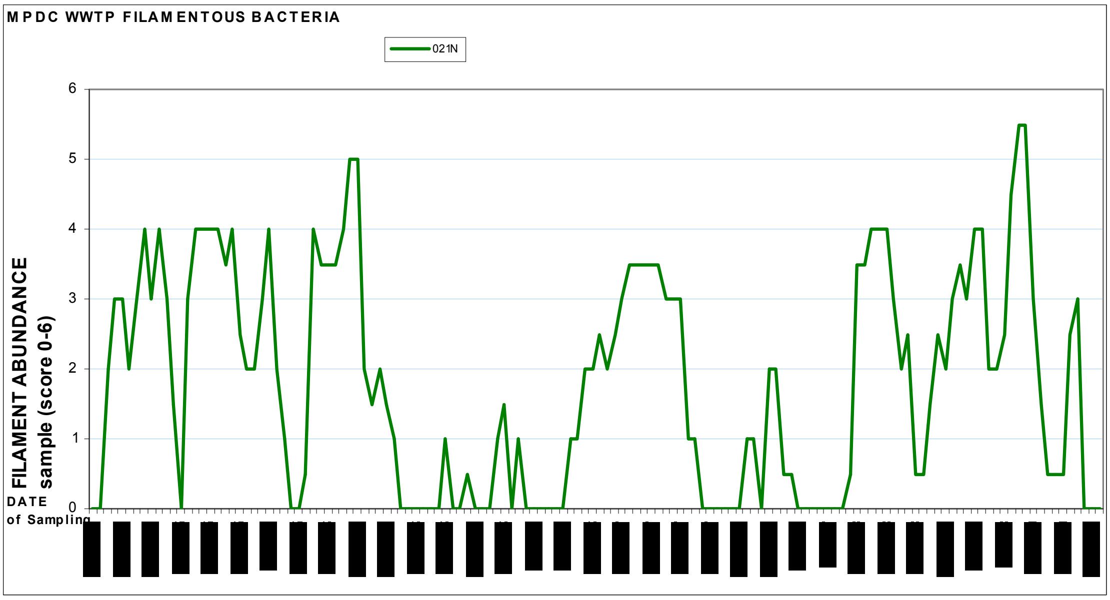


Identifying which organisms were prolific (or absent) in the biomass was compared against these seasonal peaks and ebbs. Filamentous bacteria (the “backbone” of the floc) showed considerable fluctuations throughout the observation period, with surprisingly little correlation between the selection factors and influent or effluent strength. Selection factors studied included readily degradable (soluble) food and slowly biodegradable food {RBBOD & SBBOD respectively}.

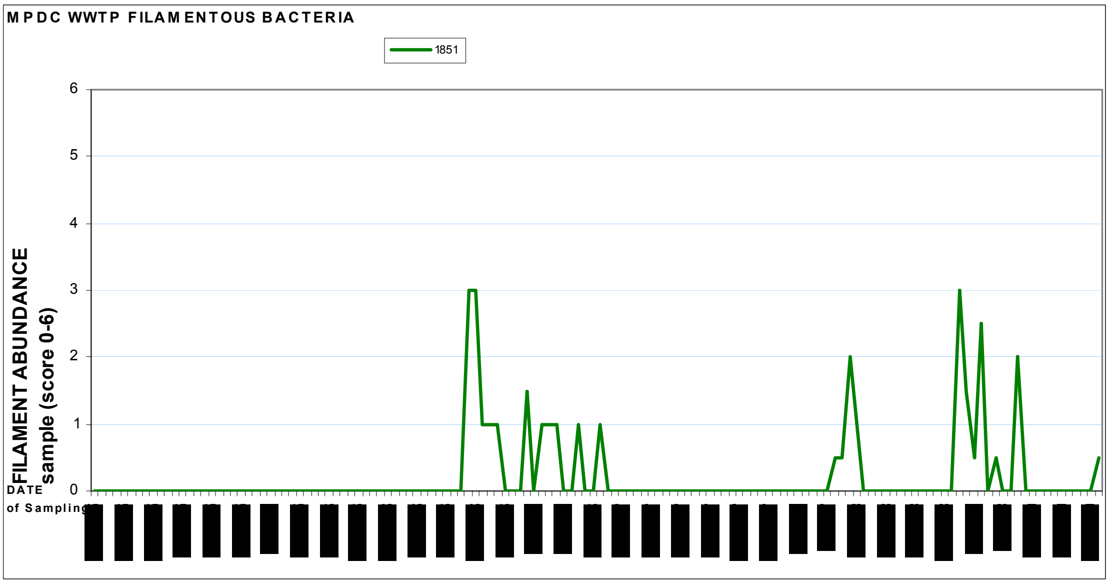


Some RBBOD favored filaments such as Nostocoida limicola (N. limicola), Haliscomenobacter hydrossis (H. hydrossis) were common in the biomass nearly all of the time, irrespective of season, loading, MLSS or any other factor aside from both being favored by low dissolved oxygen (&/or somewhat anoxic environments). This is more a reflection of general operation and it’s constraints than a reflection of the influent.



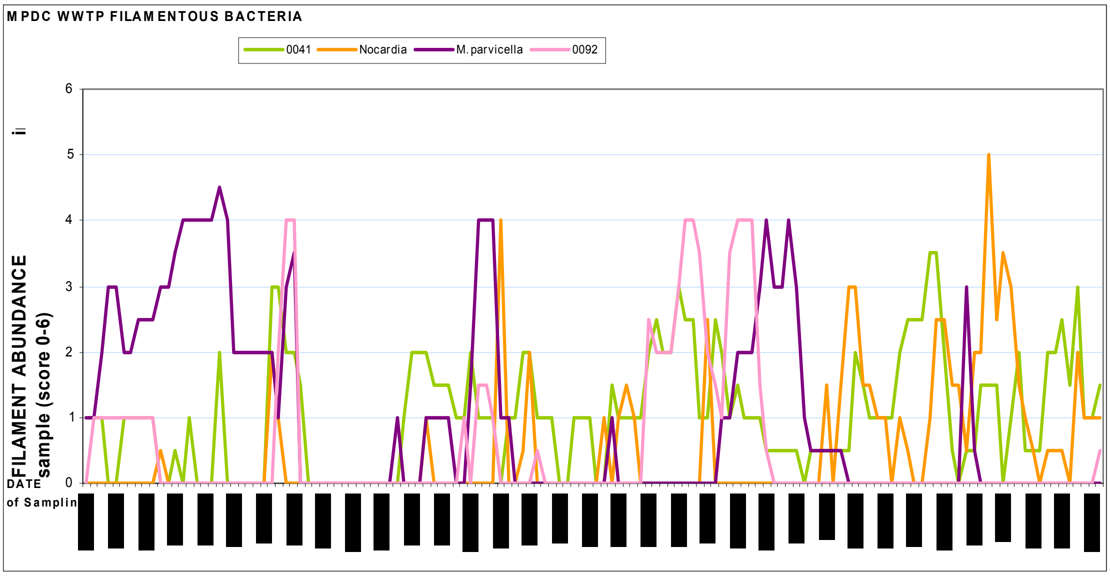


021N, a very versatile and resilient filamentous bacteria, often found in the biomass of dairy effluent receiving wastewater treatment plants, was common throughout each year aside from the coldest winter months July – October.

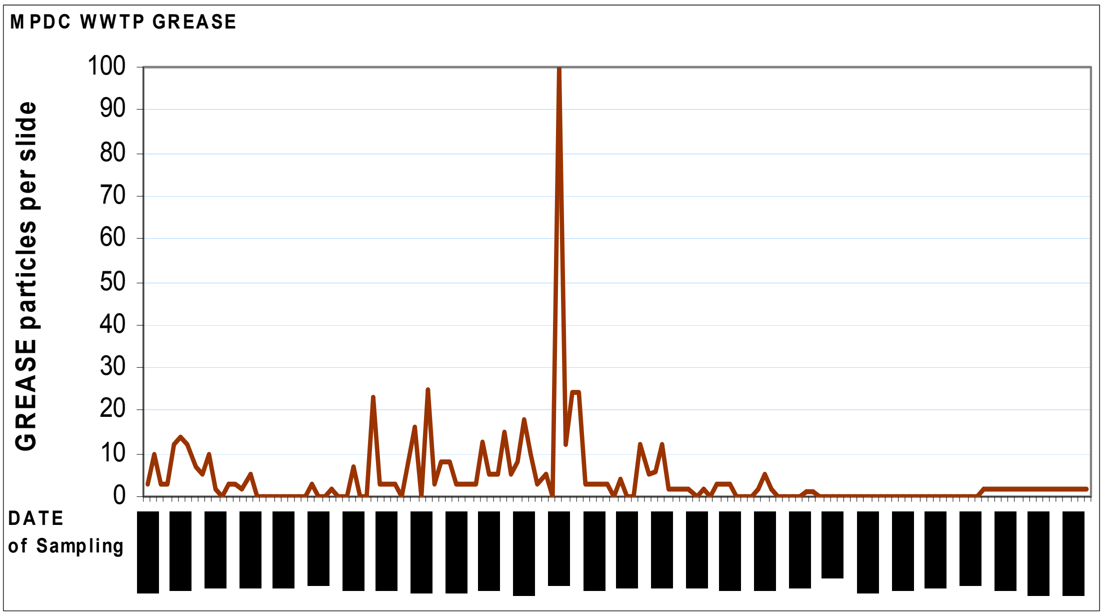


1851 was one of the few filaments that showed a definite seasonal loading preference, appearing for a short period each year, but not necessarily when factory input would be highest.

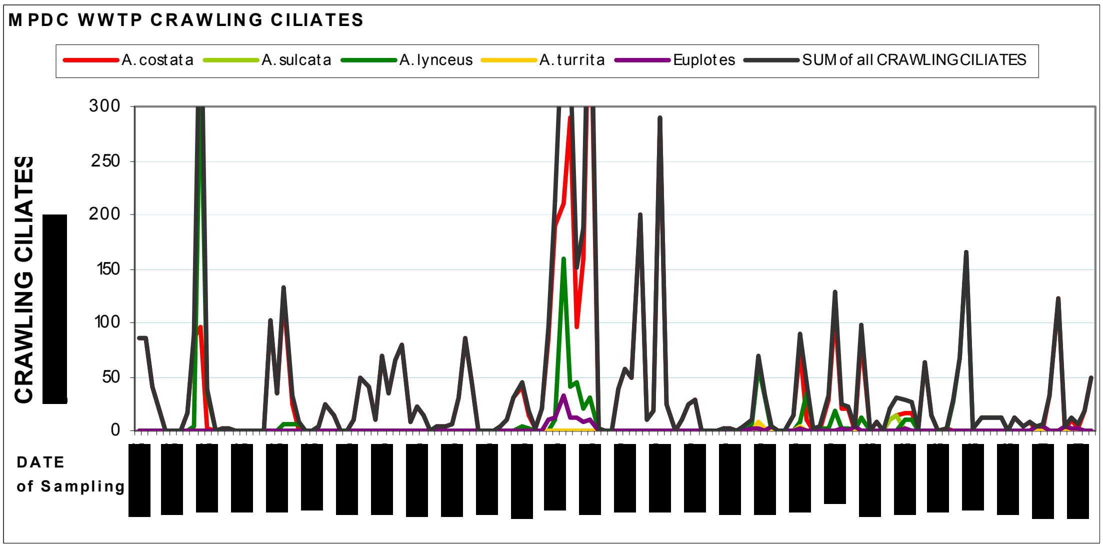
Overall filaments favored by slowly biodegradable food types were dominated by 0041. This filament was at time accompanied by Nocardia amarae (& N. pinensis at times) and Microthrix parvicella (M. parvicella), with infrequent appearances by 0092. 0092 was often, but not always associated with the winter months. All these fat loving filaments would be inclined to appreciate the effect of colder temperatures consolidating fat & grease particles.



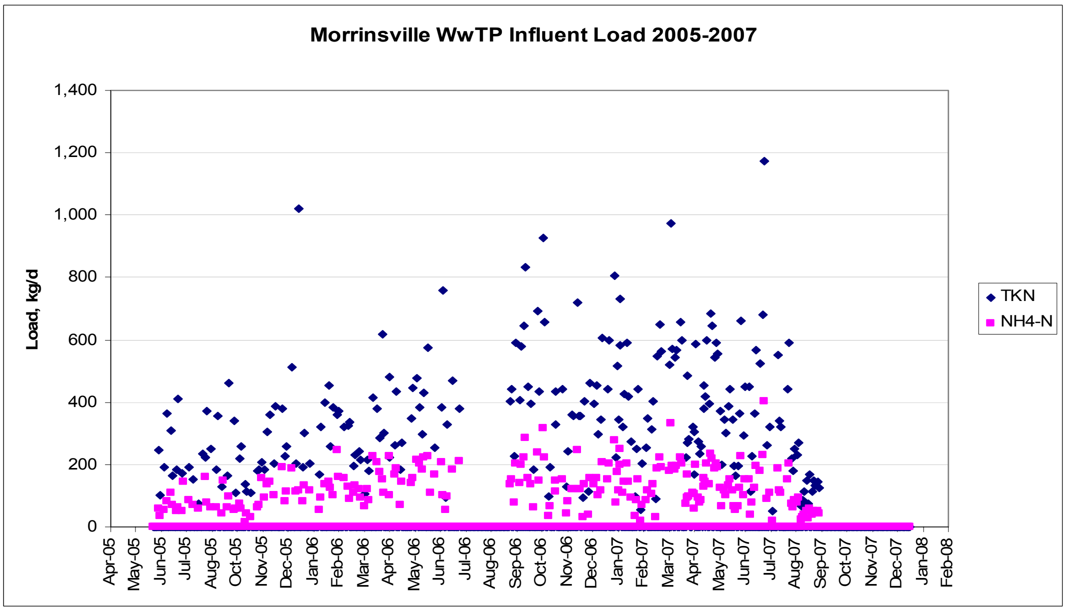
A huge influx of fat from an uncontrolled unusual factory discharge gave rise to the spike in grease and fat loving filaments in October 2006.

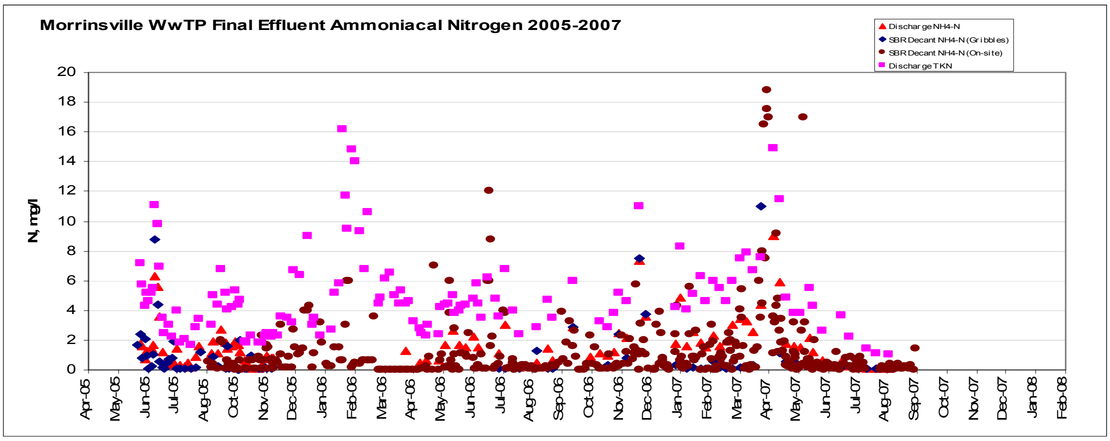


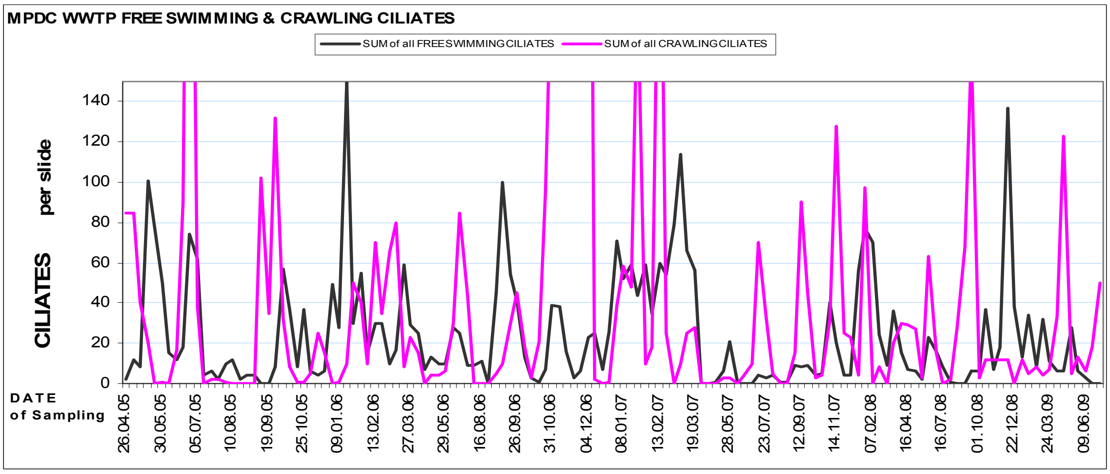
So what of the various groups of protozoa. A clear indicator of extraordinary fat discharge to the treatment plant was observed in the crawling ciliate population around the time of the October 2006 event. This would lead me to speculate that along with indicating good nitrification by the biomass, their appearance may be linked to (unreported?) minor abnormal fat discharge events (butter fat?).



On-site test results for NH_4^+-nitrogen and NO_3-nitrogen on the influent and corresponding effluent were compiled. Results for COD (influent) and BOD (effluent) were also collected. These, along with flow data allowed approximation of nutrient load. Treatment efficiency was able to be determined, both in terms of actual kg/day removal, and also % efficiency of removal for various nutrient types.

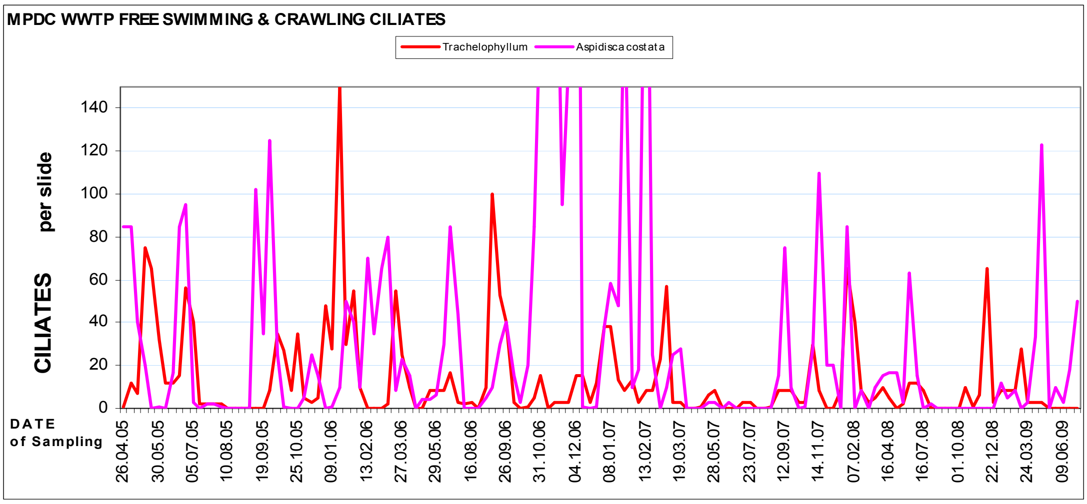


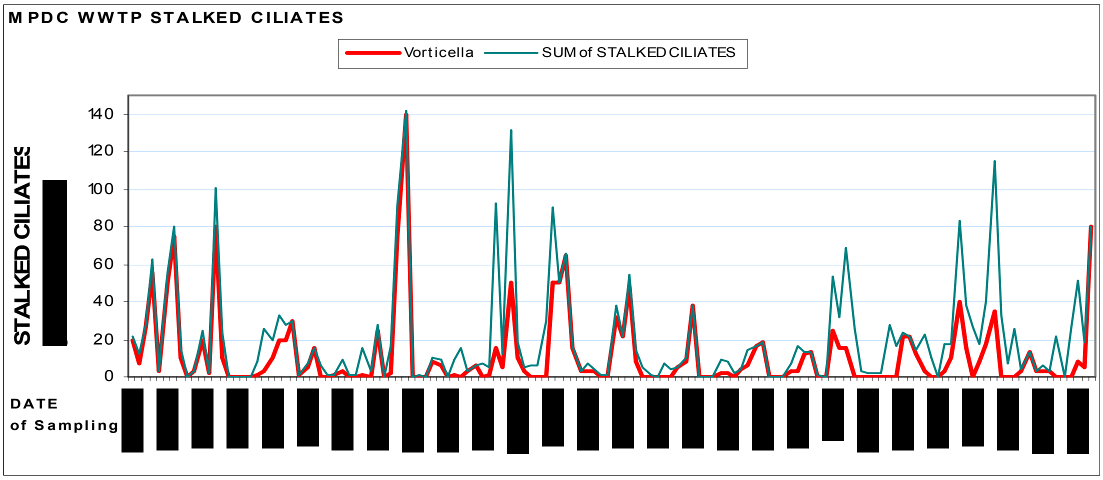




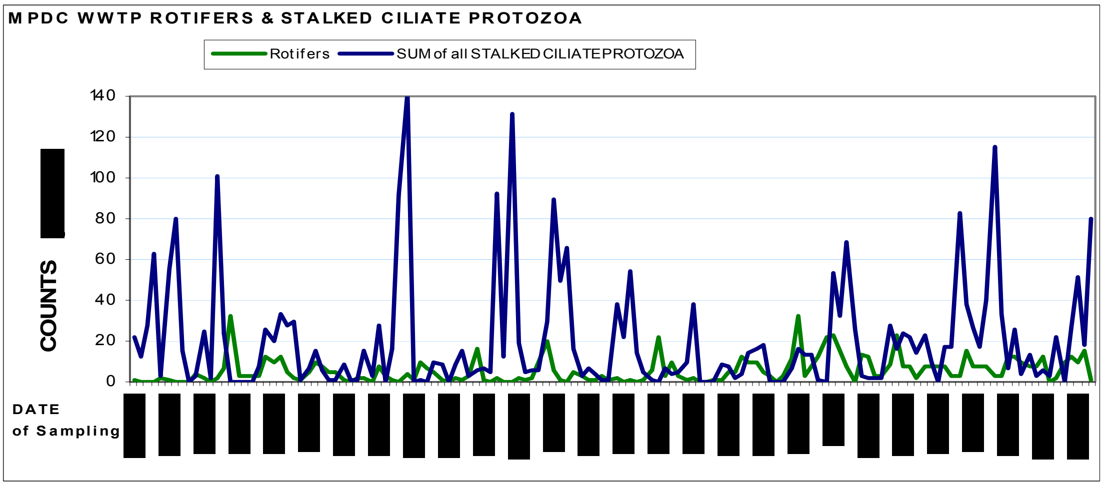
Interestingly the free-swimming ciliates and crawling ciliates (both groups of protozoa) had an inverse relationship for much of the period under study.

This was particularly apparent in the comparison of the most commonly observed organism of each of these groupings.





Stalked ciliate protozoa were dominated by Vorticella, with irregular appearances by other species. August-September-October seemed to be months where higher than normal numbers of stalked ciliates were observed. Crawling ciliate numbers were often higher around these times too. Peaks in numbers of Rotifers (a Metazoan (multi-cellular animal) were fairly co-incident. This is not surprising given they both are feeders on floating bacteria and other small suspended particles.



Attempts were then made to use the first two years worth of data to predict the results for the following year.
Prediction was made for biomass response to influent change, with factoring in of any similarly timed operational changes. Accuracy of predictions – i.e. did the expected micro-organisms appear/ disappear/ increase/ decrease as predicted? was noted. Prediction was then made for treatment efficiency compared to actual observed biomass composition during this second period. It is anticipated that different microbes within the mixed liquor will show varying degrees of predictive success. Phase Two of the investigation involves using those micro-organisms indicated as strongly linked to, or predictive of, prevailing mixed liquor conditions.

The relative presence of some of these same micro-organisms, in an MBR wastewater treatment system, has also been fairly regularly monitored over a couple of years. The aim of this comparison phase will be to see if the micro-organisms' derived predictive ability is transferable across differently configured and loaded treatment systems.

About the author: Liz Millan has more than 25 years experience working on wastewater treatment plants and laboratories. Her business Scope Global Ltd provides biological treatment support and process troubleshooting, laboratory support (staff selection, methodology, QA audits and manuals), biological sample microscopic examination and video capture, customised training DVDs and manuals, on-site or centralised training for engineers, treatment plant and lab staff in wastewater treatment and laboratory theory and practice.

contact Liz at: scope-global.clear.net.nz