An Ultrasonic device for algae control

Practical experiences of Ultrasonic units for algae control

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Introduction

The use of ultrasound for controlling algae has been known for some time. However the practical use of such technology is relatively recent and utilises the resonance effects of ultrasonic waves on the algae cell. The ultrasonic waves are derived from the creation of certain sound vibrations with periodic interruptions. A submerged transducer that is specifically designed and purpose built to be small and water resistant generates the ultrasonic vibrations. These sound shock waves are directed at the vacuole of the algae. Initial observations show that the shock waves probably weaken the cell membranes causing the algae to collapse in on themselves and sink out of suspension.

This new approach is environmentally friendly, cost effective and uses no chemicals. These ultrasonic vibrations, which are inaudible to people, are no threat to human beings, animals or fish.

These ultrasonic devices are used in horticulture, aquaculture, potable and wastewater applications. The transducers used are capable of emitting ultrasonic vibrations up to a range of 200 metres, covering a radius of 180 degrees.

This presentation will provide some illustrations of a number of installations where effective algae control has been achieved in different environments.

The experiences gained from these and other installations has been utilised to design and build a new unit, the SS-500 unit, which is being introduced at this NALMS meeting. This unit has been tested in a number of locations, one of which is described in this paper. The unit, which incorporates significant improvements, has been effective in controlling algae in a drinking water reservoir and in a smaller trial be shown to kill Mycrocystis, a blue green algae.

Installation experiences

Highwell, Wantage, United Kingdom

This was the first ultrasonic unit installed by the author in August 2000.

Highwell is a house situated in the Berkshire Downs and has a lake in the grounds, which is fed by a local stream. The lake had a history of algae

blooms (floating algae mats), mainly Cladophora glomerata and flows into the lake of the adjacent house spreading this algae problem to several properties. The lake was also monitored by The Environment Agency to observe the effect of chemical treatment. No effective algae control was achieved by chemical additions and the owner eventually contacted the author about ultrasonic units he was marketing. The owner actually built himself a pontoon to go out on the lake and rake off the algae but never succeeded in achieving any effective control.

The ultrasonic unit was installed close to one bank of the lake with the transducer pointing across the lake. This location was chosen because of its proximity to a power supply (240V domestic power supply).

This installation was observed visually by the Centre For Aquatic Plant Management in terms of percentage cover of floating mats of algae of the two main species and an assessment of the percentage cover of vegetation in the lake as a whole. These data can be used to assess the effectiveness of the ultrasonic unit in preventing formation of algal mats.

Observations on Rainbow trout accustomed to feeding within 3 metres of the installation site of the unit, showed that feeding behaviour was not altered. It was therefore assumed that the ultrasonic device had no discernible effect on Trout.

The Spirogyra species growth was observed for the first time in the lake and it is hypothesised that this alga had taken the place of Cladophora glomerata in this system. The mode of growth was unusual in that it floated in discrete circular lumps, rather than in irregular masses as is usually observed.

The only Cladophora. glomerata, remaining in the lake was in the shadow of the moored pontoon, where the floats created a sound shadow in the water. The aquatic moss Fontinalis antipyretica dominated the remainder of the lake.

The installation of this first ultrasonic unit was a significant development since it introduced the technology into a new market and laid the foundation for further installations in the U.K. The effect of the unit can be seen in the pictures of the lake taken before the installation and some three months after the installation. These pictures, shown below Figures 1 and Figure 2, clearly demonstrate the effectiveness of the unit in killing algae.

The area assessment details are also given below in Table 1 and Figure 3 and clearly show the same results over a fifteen-month period of observation.

This effective algae control has been repeated in over seventy installations in the U.K. since this first installation with a range of ultrasonic unit sizes.

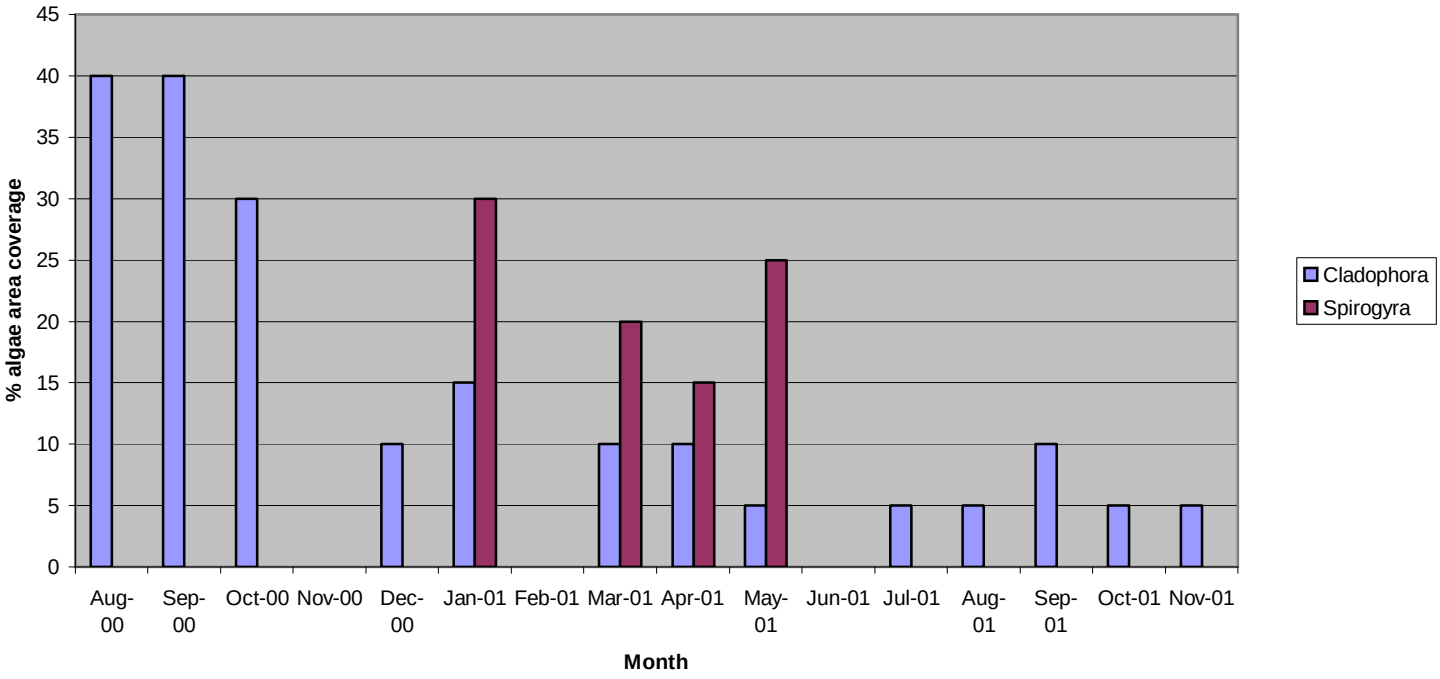
Figure 1 Highwell before installation of ultrasonic unit

Figure 2 Highwell after installation of ultrasonic unit

Table 1 Highwell Ultrasonic Unit Installation

Date	%algae area coverage of lake	
	Cladophora	Spirogyra
Aug-00	40	0
Sep-00	40	0
Oct-00	30	0
Dec-00	10	0
Jan-01	15	30
Mar-01	10	20
Apr-01	10	15
May-01	5	25
Jul-01	5	0
Aug-01	5	0
Sep-01	10	0
Oct-01	5	0
Nov-01	5	0

Figure 3 Highwell Ultrasonic Unit Installation



This Highwell installation was the first U.K. installation and since then over seventy ultrasonic units have been installed and all have worked successfully in controlling algae in lakes, ponds and drinking water reservoirs. The author has pictures of a lot of installations but these cannot be included in this presentation.

Over the last three years it has become evident that there is a wide variety of applications where algae and other organisms can be eliminated by this particular ultrasonic technology. The global application potential appears to be very large with significant cost savings in many industries.

This paper however is devoted to introducing this ultrasonic technology using actual installations and some current development work, which confirms the effectiveness of these units in controlling algae in different environments.

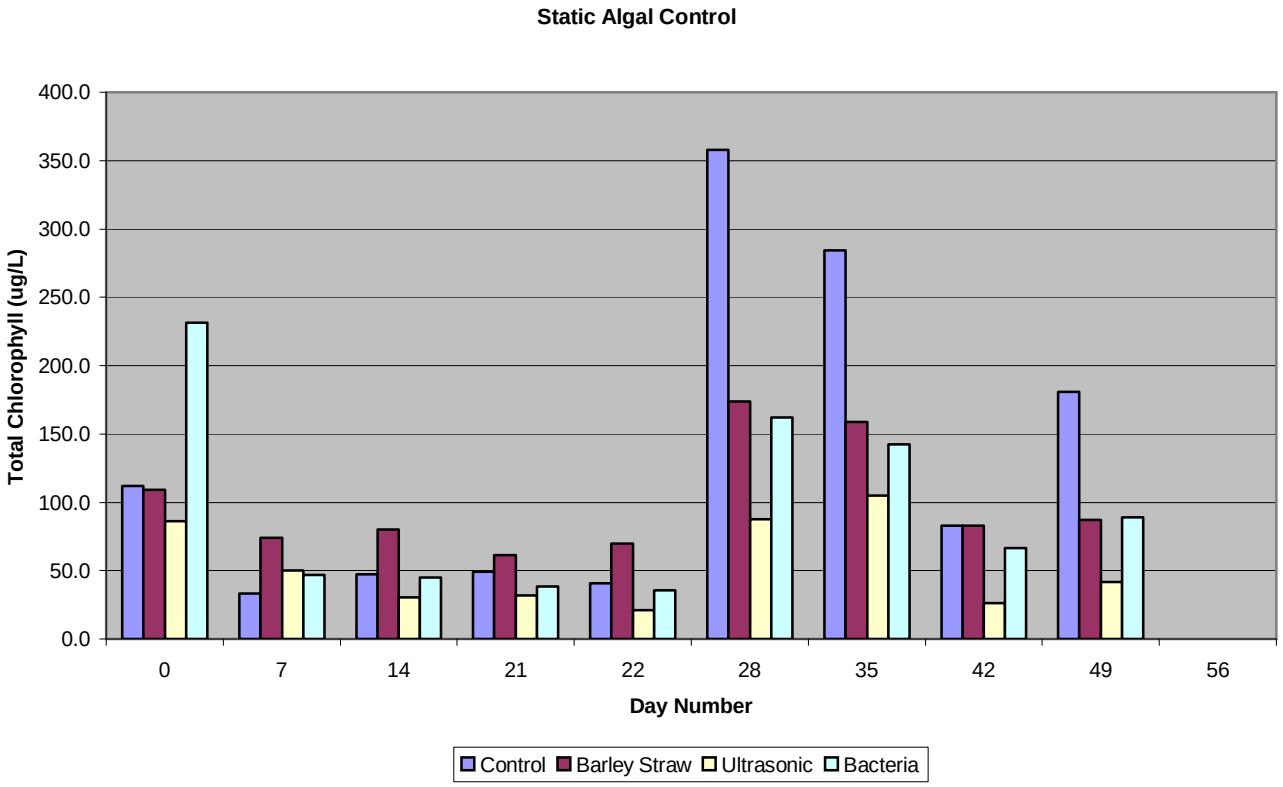
We have been carrying out some experimental work recently with a smaller ultrasonic unit to compare its effectiveness against other technologies. These results are summarised in the section below " Small Scale Ultrasonic Unit Trials" carried out at the Centre For Aquatic Plant Management.

Small Scale Ultrasonic Unit Trial

The unit was installed in a circular above ground round plastic pond attached to a float and allowed to float under the water surface. Chlorophyll levels in the pond were determined at weekly intervals and the algae development observed at the same time.

The ultrasonic unit prevented algae growth and the pond was clear after three – four weeks operation of the unit. Figure 4 below shows the relative performance of this unit against some other static technologies in the same trial

Figure 4 Static Algal Control



The ultrasonic unit clearly is the most effective treatment, which is even more apparent after the ponds were topped up with more water between days 22 and days 28.

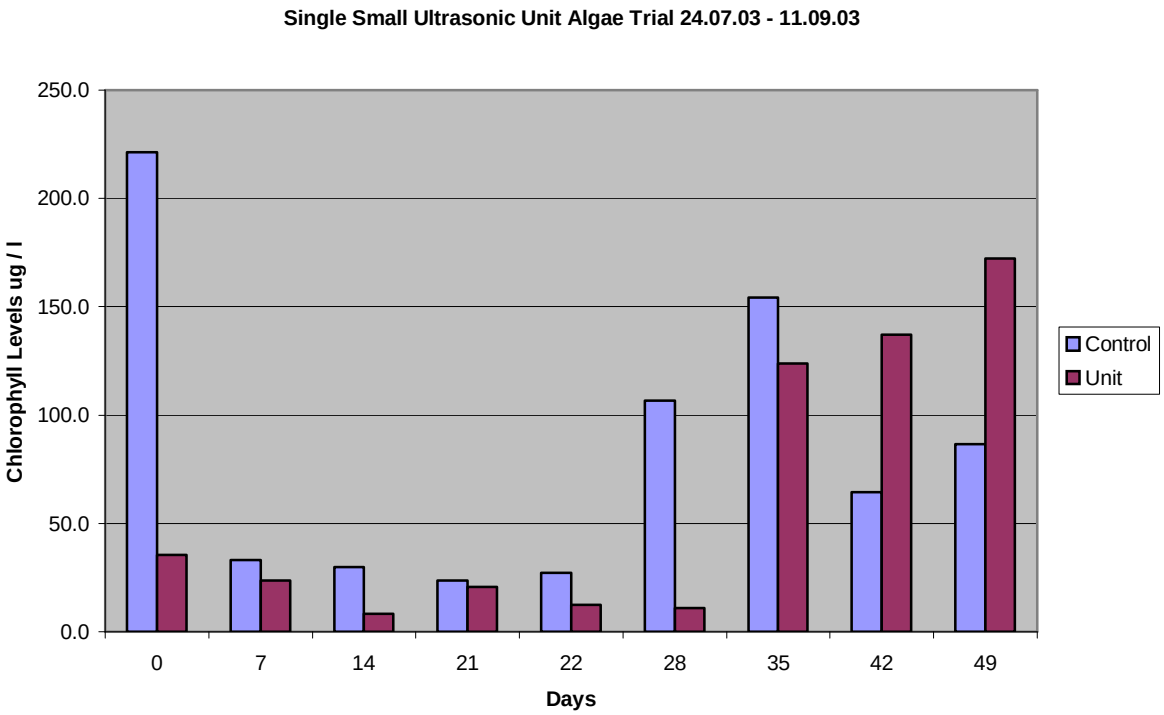
On day 28 the ultrasonic unit was removed from the pond and the chlorophyll level in the pond monitored to observe the effect of its removal.

Table 2 and Figure 5 show the results so far obtained

Table 2 Small-scale ultrasonic unit operation

Day	Chlorophyll level ug /l		
	Control	Unit	
0	221.3	35.4	
7	33.0	23.8	
14	30.0	8.2	
21	23.7	20.7	
22	27.1	12.5	
28	106.9	10.8	Unit removed
35	154.1	124.0	
42	64.6	136.9	
49	86.8	172.1	

Figure 5 Effect of ultrasonic unit removal from pond



The algae growth clearly returned after removal of the ultrasonic unit from the pond on Day 28.

Drinking Water Reservoir Trial

At the beginning of 2003 the author was contacted by a drinking water supply company who wished to discuss the potential application of ultrasonic units for controlling algae problems on their reservoirs. They had years of problems with algal blooms and at certain times of the year could not use the water from the reservoirs because of the high levels of algae growth affecting their filtration systems.

The discussions lead to a trial agreement and ultrasonic units were installed in April 2003 at one of their reservoirs at Barcombe near Lewes in South East England. This reservoir had experienced major algae problems and most years had experienced severe blooms, which resulted in weeks of disruption to usage of the reservoir water. Even last year they could not use this reservoir water for several weeks. The company had tried many technologies for algal control but none were satisfactory.

Since the installation of these ultrasonic units, even in the hottest and sunniest summer since 1997 the reservoir water has been utilised continuously for processing. The reservoir is monitored weekly for water analysis, chlorophyll levels and alga; species present in the water. The Compliance Manager has an archive of all these analyses going back over a number of years so we have been able to compare these results with the current ones obtained after installation of the ultrasonic units.

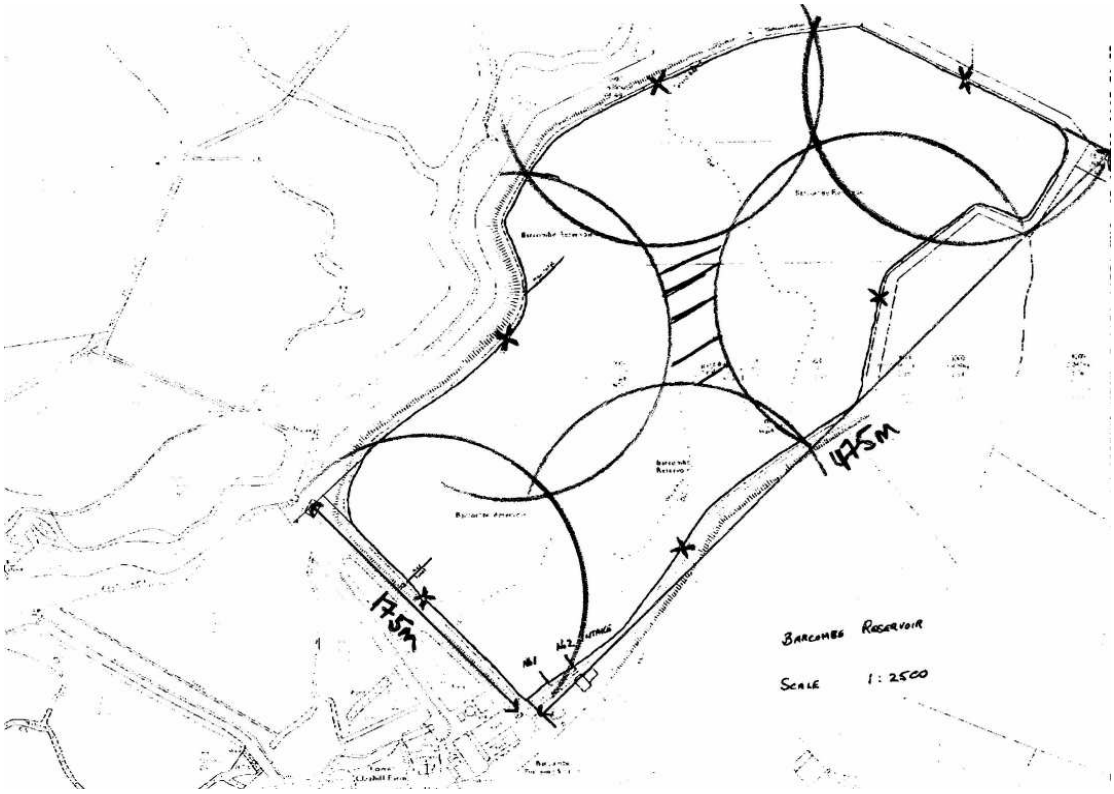
On the 11th July 2003 we installed two prototype units (SS-500) and have been monitoring their performance on a regular basis at distances of 5, 25 and 125 metres in front of the transducer face. Samples for the last monitoring were taken on the 5th September 2003, eight weeks after installation.

Routine analyses have been carried out on all these samples but in addition we have harvested algal cells from each sample for microscopy investigations of any cell damage due to use of these ultrasonic units.

These investigations are ongoing. Initial results comparing algal cells, which had been exposed to the ultrasonic waves generated by the units and the control cells, which had not been exposed to such ultrasonic waves showed that in the treated cells the plasmalemma was detached and the cell looked to be imploding.

This work is continuing and the findings will be available in the next few weeks.

Figure 6 Reservoir Plan



There is a concrete wall around the reservoir so the company could run a supply cable around the perimeter to connect the ultrasonic units to power.

The six units were installed at the locations marked with an X in March 2003 and the standard weekly monitoring continued after this installation.

The following four figures show the comparison in algae cell concentration and chlorophyll levels for 1997 and the current year 2003 and from these it can be seen that the levels for 2003 are much lower that 1997 and it is reasonable to deduce this is due to the effect of the ultrasonic units.

The Water Company has other reservoirs and it is interesting to note that these do not currently have any ultrasonic units installed. Algal blooms have developed in these reservoirs and the Company is now looking to install ultrasonic units in the near future in these locations.

The Water Company has tried numerous technologies over the years to control their algae problem and these were unsuccessful. The current six month's trial with these ultrasonic units has clearly demonstrated the effectiveness of this technology in preventing algal blooms in a cost effective manner and enabled the continuous use of the treated water for processing into drinking water and supply into their mains network.

Figure 7 Reservoir chlorophyll levels 1997

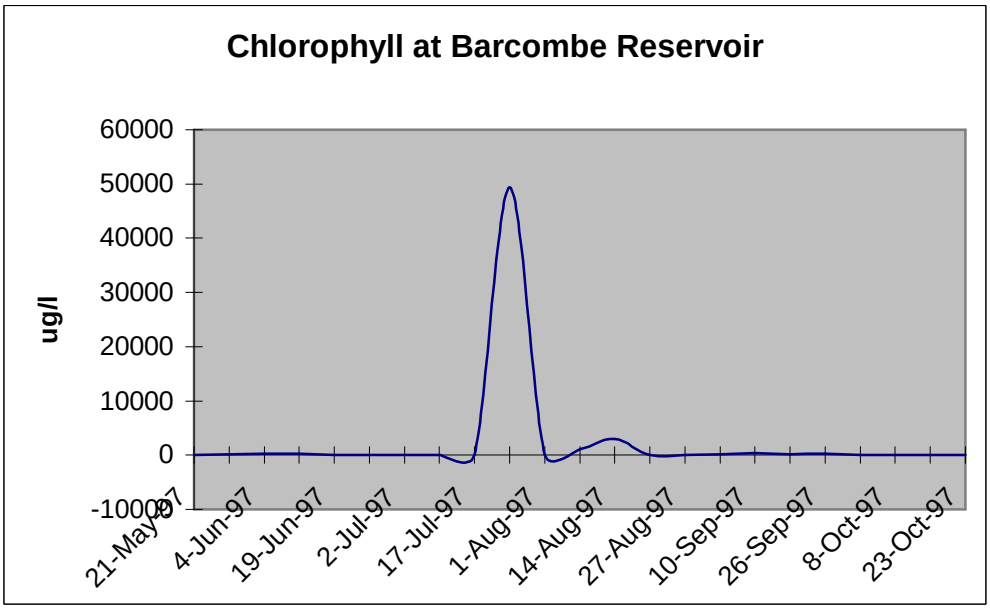
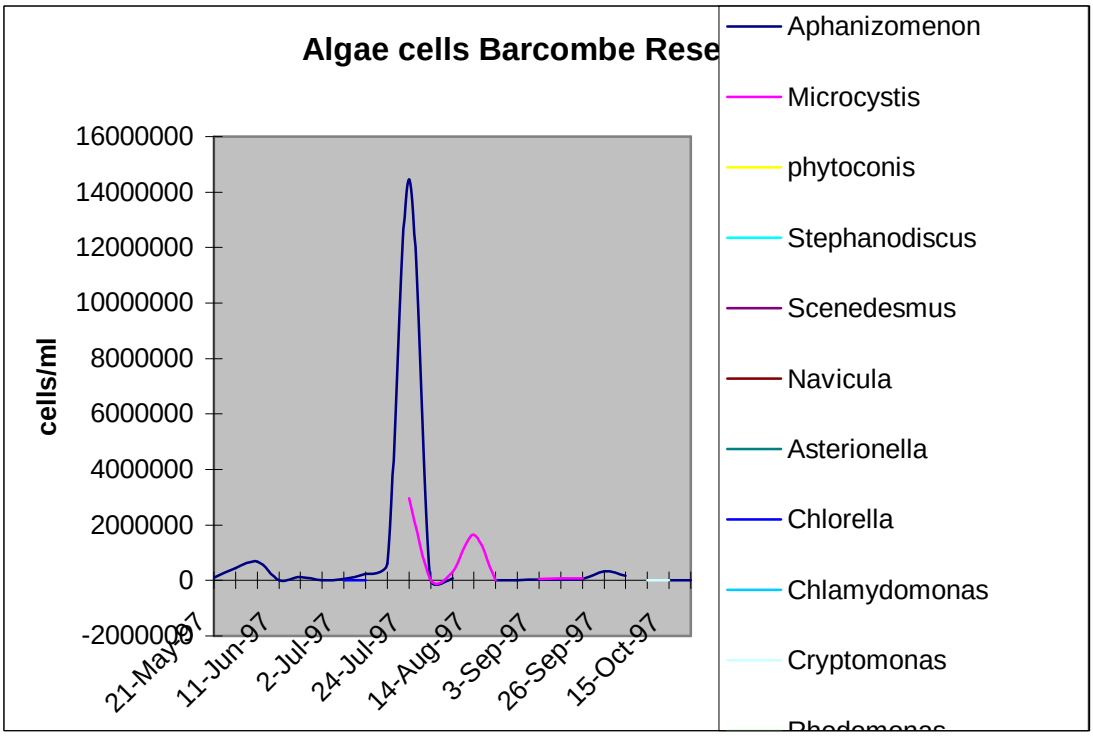


Figure 8 Reservoir algae cell counts 1997



Maximum cell count 1997 14,000,000 cells / ml

Maximum chlorophyll level 1997 50,000 ug / l

Figure 9 Reservoir chlorophyll levels 2003

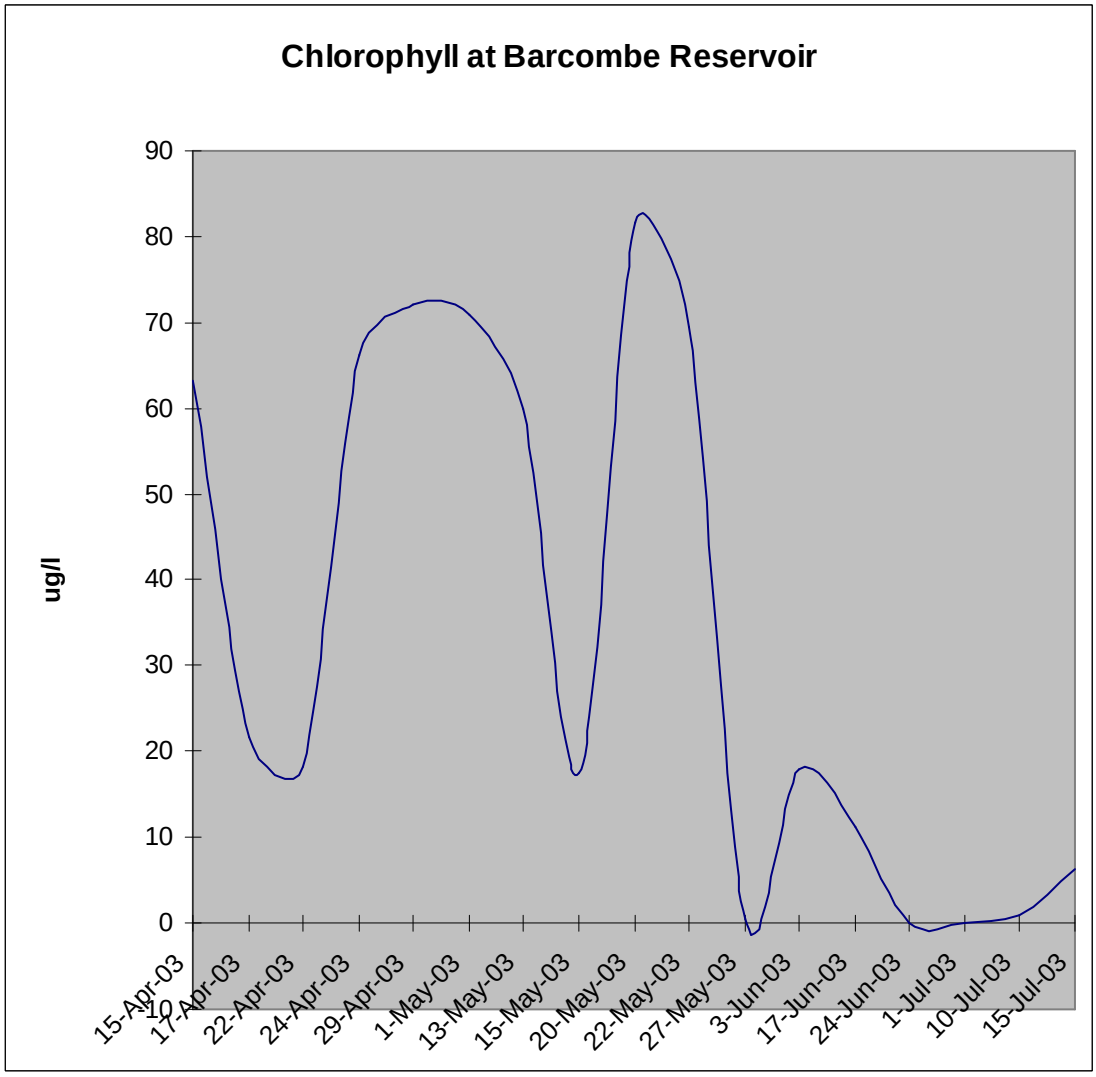
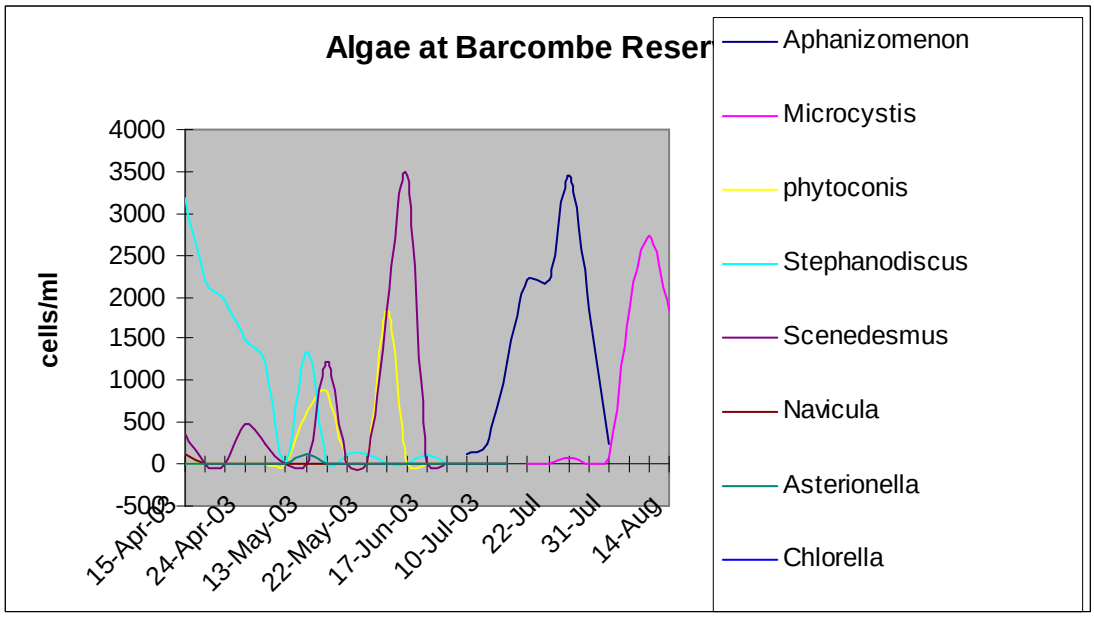


Figure 10 Reservoir algae cell counts 2003



Maximum cell count 2003 3,500 cells / ml

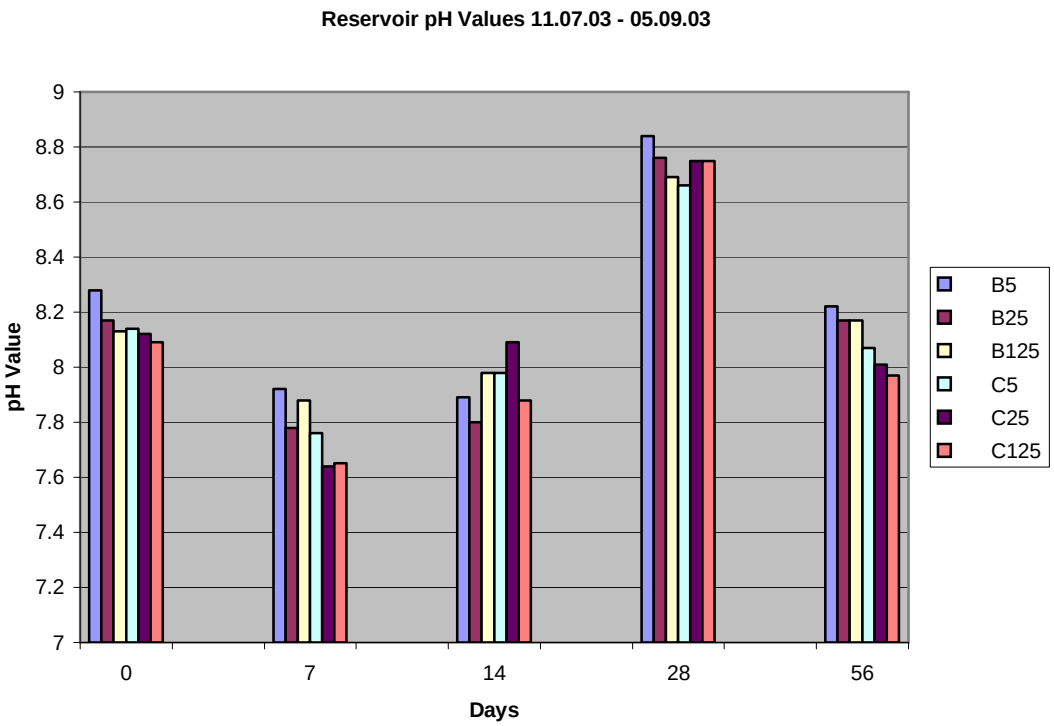
Maximum chlorophyll level 2003 83 ug / l

This dramatic reduction in algal blooms has significant benefits for the operation in that the reservoir water can be used continually without having to rely on direct river abstraction. This reduces the risk of pollution incidents directly affecting the water and disrupting treatment and if the river flow decreases the water can continually be pumped for processing.

There are other benefits such as lower chemical usage, less filter washing and hence less water wastage and less sludge production leading to savings in disposal costs.

On the 11th July 2003 the two prototype ultrasonic units (SS-500 units) were installed at one end of the reservoir and their operation monitored at the three distances from the face of the transducer. Unit B was installed on the river intake side of the reservoir and Unit C on the bank opposite the river intake.

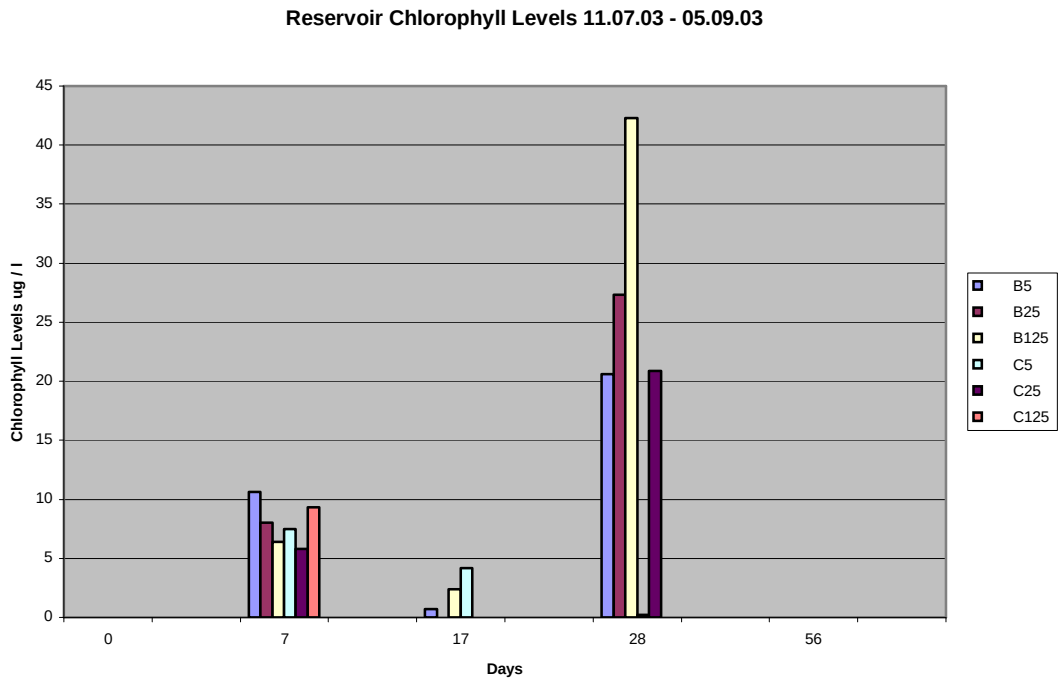
Figure 11 Reservoir water pH values, prototype ultrasonic units



During this two-month period there was no interruption in pumping the raw reservoir water for treatment.

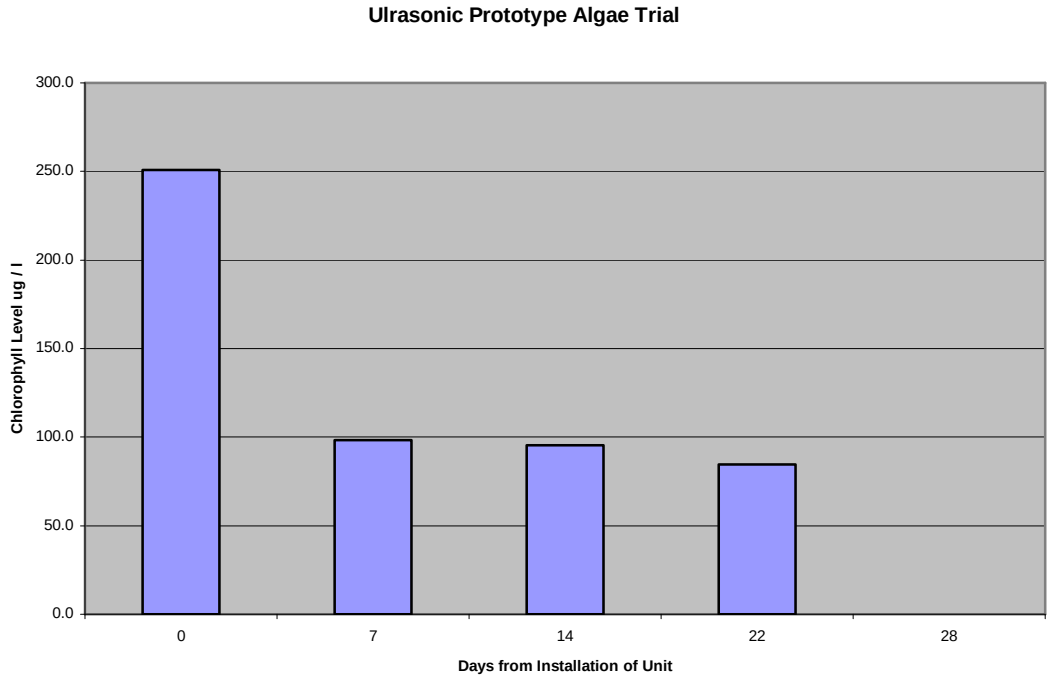
Chlorophyll levels were also monitored at the same time and these results are shown below.

Figure 12 Chlorophyll levels prototype ultrasonic units



Whilst this trial was running the author carried out another investigation with a third prototype unit, which was installed in a tank at the Centre for Aquatic Plant Management on the 20th August 2003. Figure 13 gives the results of this trial.

Figure 13 Chlorophyll levels in Microcystis prototype trial



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