WATER BLENDING IN COMMERCIAL CATFISH PONDS

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INTRODUCTION

There has been considerable interest among catfish growers and other aquacultural industry people in the southeast in the use of water blending in catfish ponds. Specifically, it has been suggested that blender use may reduce energy consumption associated with emergency aeration and/or improve water quality.

It has been postulated that photosynthetically produced oxygen, which typically results in afternoon supersaturation in catfish ponds during the growing season, may be conserved if it is mixed into sub-saturated water below the supersaturated layer. It has also been suggested that an anoxic boundary layer at the sediment-water interface may adversely affect pond water quality and that eliminating this layer by mixing oxygen-rich water to the bottom may improve culture conditions.

Water "blenders" are actually devices used to establish horizontal currents in the ponds. The blenders which have appeared to date are powered by electric motors which are used to turn a propeller or screw which provides the propulsive force. Early references to this approach came from Busch et al. (1978) who found mixed benefits. More recently, Tucker and Steeby (1995) tested 2.24 kW (3 hp) blenders in 4 acre research ponds. Their blenders were installed near the pond bank and oriented to direct the flow along the long axis of the pond, creating a circular flow pattern. They found that circulating the pond water produced a marginal decrease in the total energy used in the ponds (emergency aeration + blending *vs* emergency aeration alone). They found no significant difference in nitrate, nitrite, ammonia, or chlorophyl *a* concentrations.

Although the results from the study by Tucker and Steeby (1995) were not encouraging, interest in this approach and anecdotal reports about its efficacy continued to abound. The present study represents a repetition of the work by Tucker and Steeby with three important differences. First, this work was carried out in commercial catfish production ponds rather than research ponds. Second, the blender design differed from the design used by Tucker and Steeby. Finally, the placement and orientation of the blenders was different.

METHODS AND MATERIALS

The work was conducted at a commercial catfish farm in Moorhead, Mississippi. Three pairs of ponds were used. The ponds which were paired were adjacent to each other and identical in size, stocking rate, and management. Each pair of ponds was at a different location on the farm in order to provide as much variety as possible with regard to wind and weather exposure. Overall, the ponds were 14 to 17 acres and had a mean depth of approximately 1m. Each pond had two 7.5 kW (10 hp) paddlewheel aerators to provide emergency aeration.

One pond from each pair was selected for blending. One 2.24 kW (3 hp) blender (S&N Sprayers, Greenwood, MS) was installed in each blended pond. The blender had a barrel roughly half the diameter of that used by Tucker and Steeby (1995) and propelled the water using a screw type impeller. The blender directed the generated current toward the middle of the pond along the pond's long axis. Blender installation occurred during autumn 1992.

In order to monitor power usage, totalizing time meters were installed in parallel with each aerator and blender. When an aerator or blender was turned on, the duration of operation was recorded by the meter. The blenders were operated approximately 7 hours per day (10 am to 5 p.m.) during the 1993 growing season. This corresponded to the period in which most of the photosynthetic oxygen production occurred in the ponds. The blenders were operated 24 hours per day during the 1994 growing season in order to provide maximum pond mixing. The "growing season" was defined as June through October and corresponded to the period when ponds were not completely mixed naturally by wind and weather. Blender operation was controlled using timers. The aerators were operated as needed to provide emergency oxygen. Meters were read at approximately 1 week intervals during both growing seasons.

During both growing seasons, routine water quality measurements on the 6 ponds were conducted at biweekly intervals. These included ammonia (NH_3-N), nitrate (NO_3-N), nitrite (NO_2-N), and chlorophyll *a* concentrations. All determinations were conducted using standard methods (APHA 1989). During July-September 1994, two Campbell CR10 data loggers were installed, one each in the middle of one pair of ponds to evaluate the effect of mixing on vertical temperature profile. Themocouples were used to monitor temperature at 5 depths (just beneath the water surface, 15 cm, 30 cm, 60 cm, and 90 cm).

RESULTS AND DISCUSSION

During the first year, it appeared that regular operation of the blender significantly ($P < 0.05$) reduced the emergency aeration requirements in all of the ponds observed (Figure 1). The difference was more pronounced in the first part of the season than it was later. There was not a time in any pond when the aerator power consumption in a blended pond exceeded that of an unblended pond.

The amount of energy saved through blender use was, in general, significantly ($P < 0.05$) less than the energy required to operate the blender (Figure 2). There was a period during the first part of the growing season when total power consumption in the blended ponds was less than that of the unblended ponds. After the fourth week, however, use of the blenders became disadvantageous from a power consumption standpoint. The magnitude of the power consumption difference was, in general, quite small (approximately 100 kW-hrs / week), suggesting that corollary benefits might make blender use desirable.

Measurements of NH_3-N, NO_3-N, NO_2-N, and chlorophyll a (Table 1) showed no significant difference between levels in the blended and unblended ponds ($P < 0.05$). The data were, however, somewhat suggestive. Means for NH_3-N and NO_3-N were, for the most part, lower in the blended ponds than in the unblended ponds. The mean chlorophyll *a* concentrations tended to be higher in the blended ponds. It was suggested that the modest impact of the blenders on pond water quality may have been due to their limited operation. The 1993 data indicated that use of the blenders could probably not be justified on the basis of energy conservation. It was therefore decided, for the 1994 season, to run the blenders constantly in order to maximize their impact, if any, on the quality of the pond water.

Data on power consumption from 1994 was similar to that of the previous year. The amount of emergency aeration required in the blended ponds was significantly less than that of the unblended ponds ($P < 0.05$). When power consumption by the blenders was considered, the total power consumption of the blended ponds was significantly greater than that of the unblended ponds ($P < 0.05$). Figure 3 summarizes energy requirements for blended and unblended ponds during both growing seasons. The increase in the magnitude of the energy required for blending is due to the increased running time of the blenders (from 7 hrs/d to 24 hrs/d).

Examination of the water quality variables measured during the 1994 season showed no significant differences ($P < 0.05$) between the blended and unblended ponds (Table 1). In contrast to the previous year's data, the relative distribution of the means was not even suggestive of an effect; mean blended values were about equally likely to be greater or less than their unblended counterparts. Based on the variables measured, one must conclude that during 1993 and 1994 the blenders did not appreciably improve water quality and that they offered no energetic advantage to the user.

Figure 4 indicates that the blenders did, indeed, vertically mix the pond water, at least at the center of the pond. By examining the temperature record, it was found that the magnitude of the vertical temperature gradients in the ponds was maximum at about 4 p.m. in the afternoon during 1994. The mean vertical temperatures of an unblended and a blended pond at 4 p.m. are illustrated in Figure 5. On the average, the unblended pond had a much more pronounced temperature gradient than did the blended pond.

It is also interesting to note, however, that a small but persistent temperature gradient existed between the surface and the 90 cm mark in the blended ponds (Figure 5). This suggests that vertical mixing was not complete to the bottom thermocouple in the blended pond. Since the bottom thermocouple was approximately 10 cm above the sediment-water interface, it may have been that an anoxic boundary layer remained relatively intact at mid-pond and, presumably, many other locations as well. On this basis, it is possible to argue that oxygen rich water may not have displaced the anoxic layer in much of the pond and that beneficial effects of such mixing on the chemistry at the sediment water interface remain untested.

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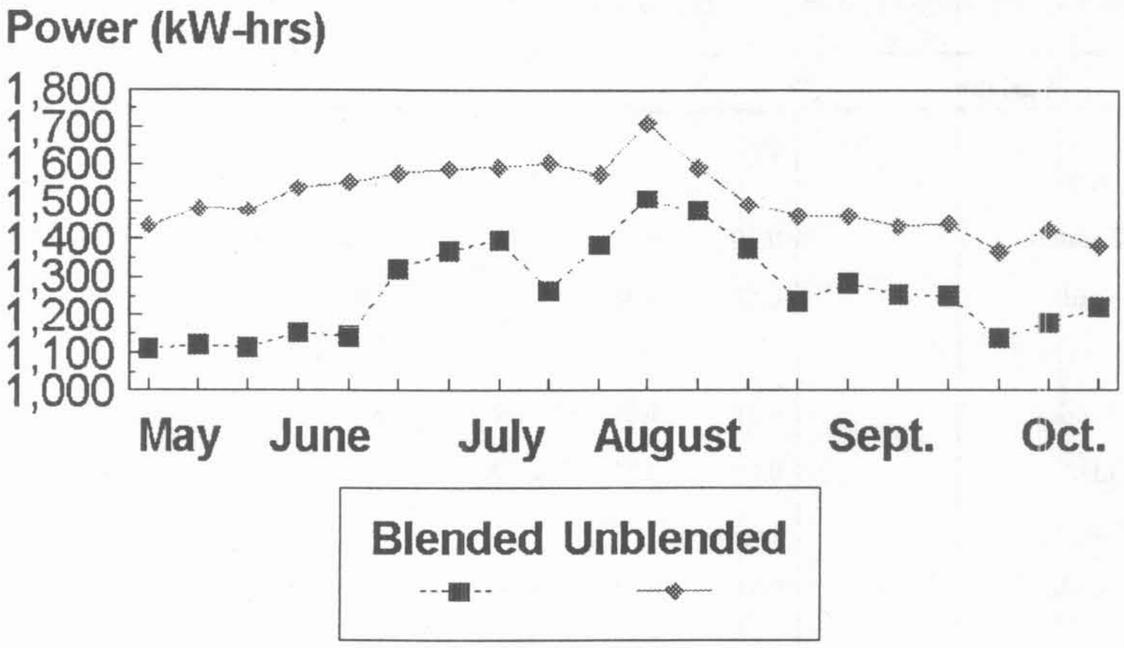

Figure 1. Power consumption by emergency aerators in blended and unblended catfish ponds during the 1993 growing season. Power consumption of the blenders is not included.

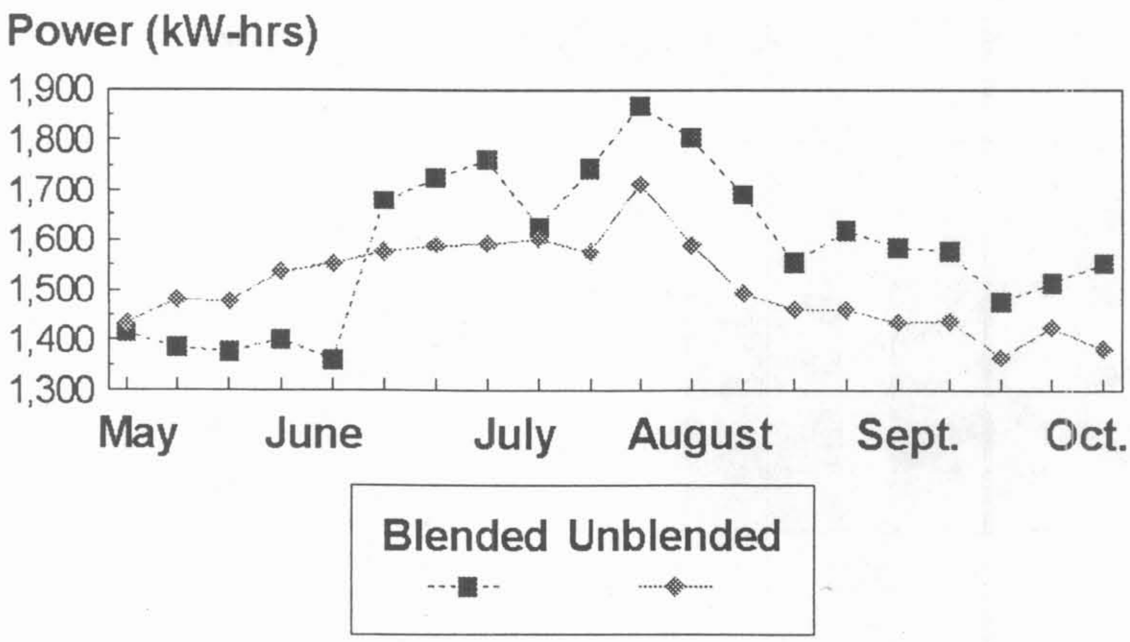

Figure 2. Total power consumption in blended and unblended catfish ponds during the 1993 growing season. Power consumption of the blenders is included.

Table 1. Mean water quality variables for the 1993 and 1994 growing seasons. Note that there were no significant differences between any of the means ($P < 0.05$).

Variable	1993			1994		
	Pr1	Pr2	Pr3	Pr1	Pr2	Pr3
NH_3-N (mg/l)						
Unblended	0.79	0.26	3.47	0.57	0.66	2.35
Blended	0.52	0.38	2.38	4.39	0.47	2.36
NO_3-N (mg/l)						
Unblended	0.31	1.24	0.02	0.47	1.18	0.14
Blended	0.10	0.57	0.03	0.05	0.97	0.20
NO_2-N (mg/l)						
Unblended	0.11	0.34	0.04	0.08	0.09	0.10
Blended	0.15	0.25	0.05	0.43	0.04	0.13
Chlorophyl *a* (µg/l)						
Unblended	516	495	542	607	334	453
Blended	654	597	574	289	450	404

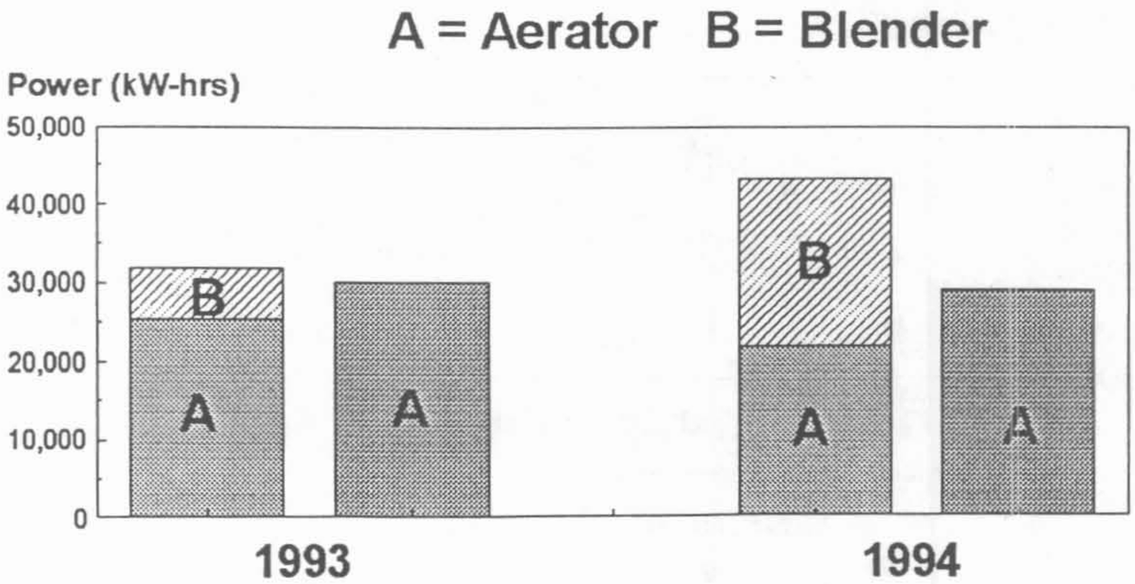

Figure 3. Aerator (A) and blender (B) energy requirements for the blended and unblended ponds during the 1993 and 1994 growing seasons.

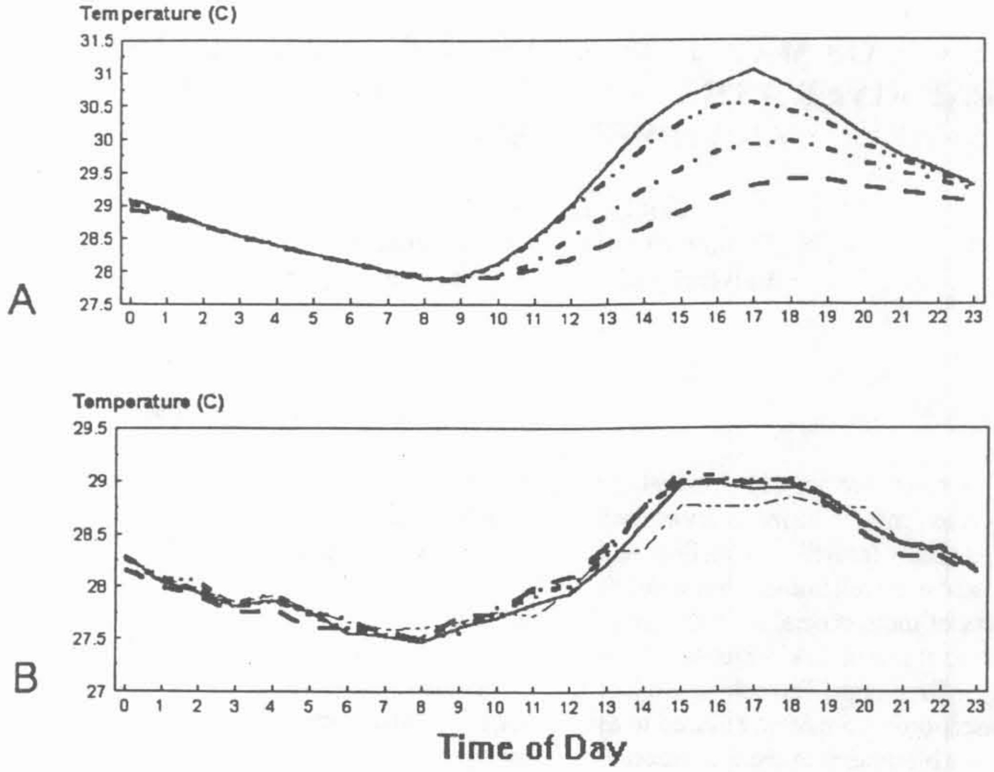

Figure 4. Mean hourly temperatures for unblended (A) and blended (B) ponds, July-Sept., 1994.

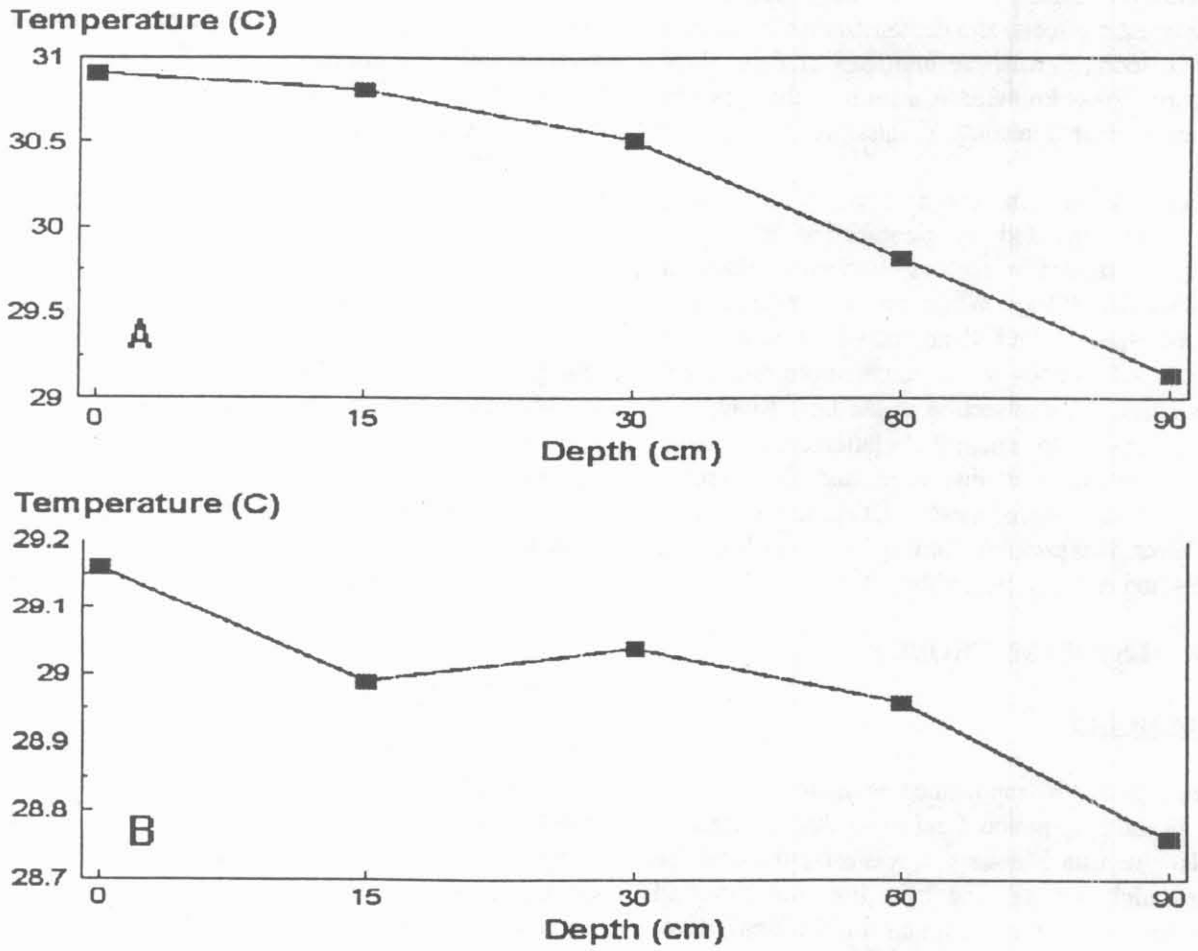

Figure 5. Mean 4 p.m. temperatures in an unblended (A) and a blended (B) pond, July-Sept., 1994.