Suggested Management to Improve Quality and Reduce Quantity of Channel Catfish Pond Effluents

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RECENT INTEREST IN REGULATING aquaculture effluents has caused researchers to focus on characterizing pond effluents and developing techniques to reduce volume and improve quality of these effluents. Analyses of waters from commercial channel catfish ponds indicated that concentrations of potential pollutants such as plant nutrients, organic matter, and solids were higher than those found in typical receiving streams. Unless ponds stratified, there was little difference in concentrations of potential pollutants between surface and bottom waters. Aeration is an effective technique for preventing thermal and chemical stratification. The water in most catfish ponds is thoroughly mixed by aeration, so the composition of their effluents should closely resemble that of pond surface waters. Studies on the quality of effluents during pond draining verified that this conclusion was true for the initial 80-90% of effluent, but the last 10-20% of the effluent was much more concentrated because of the suspension of solids by bottom soil disturbance by fish and seining activities. During draining, 50% of the potential pollutants discharged from a pond are discharged in the last 10-20% of the water.

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One method of reducing the amount of effluents from ponds is to operate them without draining, which is a common practice of catfish farmers in Mississippi. Research conducted at the Auburn University Fisheries Research Unit of the Alabama Agricultural Experiment Station System revealed that, over a three-year period, it was possible to maintain adequate water quality for good fish production in undrained ponds harvested each year by seining. After several years, catfish ponds must be drained to repair levees and for fish inventory adjustment. When it is necessary to drain ponds, the last 10-20% of water in the pond can be held for two or three days to significantly reduce amounts of pollutants through sedimentation.

Pond bottom soils contribute to the pollution potential of catfish ponds. Aeration, water circulation, and pond bottom treatments may be used to enhance decomposition of organic matter in pond soils. Striving to improve sediment and water quality and reduce the volume of effluents can produce numerous positive side effects: environmental conditions in ponds can be enhanced, more efficient fish production can be achieved, and less water will be used.

A constructed wetland, tested in Hale County, was very efficient in removing potential pollutants from pond water providing that at least a two-day hydraulic retention time (HRT) was used. However, since this process requires a large amount of land, wetlands should be used for treating only a portion of the waste from catfish ponds. A 2.5-acre wetland would be required to treat all the effluents from a 2.5-acre pond with an average depth of 4.5 feet. Taking into account the two-day HRT, this process would last one week. Treating only the most concentrated effluents in the final stages of draining would minimize the amount of land needed for constructed wetlands, and significantly improve the quality of these effluents.

Research results show that catfish farmers could use the following suggestions to develop inexpensive techniques for reducing the pollution potential and volume of pond effluents:

(1) Use high quality feeds and conservative management practices.

High quality feeds improve feed conversion ratios and reduce quantities of metabolic waste and uneaten feed. Conservative feeding practices and lower stocking rates reduce feed inputs and improve feed conversion ratios. Feeds are the ultimate source of pollutants in catfish pond effluents. The main types of wastes in aquaculture are residual food, fecal matter, and metabolic by-products. Because feed is about 90% dry matter and fish are only about 25% dry matter, only 18% of feed dry matter will be recovered as fish dry matter at a good feed conversion ratio of 1.5. The remainder of the dry matter stays within the pond system to affect its water quality. Inefficient feed conversion results in poorer quality effluents because the feed not converted into fish flesh enters the pond as waste.

(2) Aerate and circulate pond water.

Maintenance of dissolved oxygen concentrations above four or five parts per million enhances the appetite of fish and encourages good feed conversion ratios. Circulation prevents stratification and enhances degradation of organic matter in pond bottoms. An evenly oxygenated pond will oxidize organic matter rapidly. Oxidation of organic matter within the pond diminishes the amount of organic matter in effluents.

(3) Minimize water exchange.

Water exchange can be used to reduce high concentrations of ammonia or other toxic substances if large volumes of pond water are exchanged at once. The displaced pond water represents a pollution load in receiving waters, and heavy water exchange should not be used unless absolutely necessary. Routine water exchange has little effect on water quality and should not be employed.

(4) Harvest fish without draining ponds or drain ponds in winter or early spring.

Many farmers use this practice already, and both research findings and experience suggest that water quality is not greatly impaired by continuous production. Ponds have to be drained every few years for repairs and fish inventory adjustment. When ponds must be drained, do so in winter or early spring when there is little or no feed input. Pond water quality normally is better in cool months than in warm months, and greater stream flow in cool months provides more dilution of pond effluents.

(5) Treat pond bottoms.

Reducing the amount of organic matter entering ponds through use of high quality feeds, more efficient feeding practices, and lower stocking rates improves the condition of pond sediments. Old ponds that have accumulations of organic matter in bottom soils can be rejuvenated after draining for harvest. Pond bottoms can be dried for several weeks and tilled to a depth of four to six inches to provide better contact of soil with air to accelerate organic matter decomposition. Acidic soils in pond bottoms should be treated with agricultural limestone to increase pH and enhance microbial activity.

Application of hydrated lime or quick lime to pond bottoms enhances ammonia volatilization and kills pathogenic organisms. However, both hydrated lime and quick lime will raise the pH so high that microbial activity will be temporarily inhibited.

(6) Reuse water.

Fish harvest is facilitated by lowering the water level in ponds to 10-20% of the full pond volume. Instead of draining ponds for fish harvest, water can be pumped to adjacent ponds and then reused in the same or other ponds. Production ponds can be built with higher levees or water levels maintained with more free board to provide storage volume. Water from one pond can be transferred to another with a low-lift pump and then transferred back by siphon.

(7) Minimize water discharge.

Maintain the water level in ponds several inches below the level of the drain pipe to collect surface runoff and rainfall without allowing the pond to overflow. This method will also help to conserve water. Watershed ponds should not have watershed areas larger than necessary to keep ponds full, because excessively large watersheds increase runoff into ponds and result in high discharge. Runoff from watersheds may be partially diverted from ponds by terracing or other means.

(8) Use ponds as settling basins.

Minimize seining activity during harvest to avoid stirring up sediments. After seining, hold the water in the pond for two to three days to allow solids to settle before draining completely. An even better method is to not discharge this last portion of water. Holding water for two days after seining reduced the discharge of settleable solids by 96%, total nitrogen by 74%, total phosphorus by 69%, and organic matter by 59%.

(9) Use constructed wetlands.

A wetland can be created by constructing a two-foot-high dike around the area in which the water will be impounded. A minimal slope is provided in order to insure water flow from one end to the other. The shape of the wetland should be rectangular with an aspect ratio of anywhere from 5-10:1. Because wetlands function best with emergent, reed swamp plants such as bulrushes and cattails, the maximum depth for a wetland should be about 18 inches. Common cattails and bulrushes can be gathered from the wild and planted in wetlands. The wetland should be large enough to provide a two- to four-day retention time for in-flowing water. Wetlands should be down slope from ponds, so water can flow by gravity from ponds into the wetland. The USDA Soil Conservation Service can provide advice on designing and constructing wetlands.

To illustrate how wetlands could be integrated into pond management, pond water levels could be lowered for fish harvest by pumping 80-90% of the water to adjacent ponds for storage, and the remaining water, which is highly concentrated with wastes, could be discharged through a constructed wetland. A wetland centrally located on a farm, or connected to an integrated drainage system would save on construction costs and use land efficiently. Such a system would also allow a wetland to be used to treat the overflow coming from ponds after rainfall. Pond drainings could be staged in time so that only one pond is being drained at a time; this will allow the use of only one wetland to treat the effluents from numerous ponds and will also allow water from a draining pond to be transferred to another drained pond so that only the effluents from one pond might need to be released into the environment and the rest could be conserved. Effluent from a constructed wetland could even be re-used if needed.