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Partitioned aquaculture systems

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Tilapia filter green algae, cyanobacteria

The water-quality characteristics of the partitioned aquaculture system (PAS) for intensive culture of catfish and co-culture of tilapia have been researched since 1989, when the system was designed at Clemson University in South Carolina, USA. PAS can achieve catfish yields up to four times higher than conventional earthen pond culture, while requiring only one-eighth as much water. Catfish production from a 0.8-ha PAS system reached 19.6 metric tons (MT) per hectare with coproduction of 6.1 MT per hectare last year.

Partitioned aquaculture combines high-density raceway culture of fish with paddlewheel-driven and high-rate algal growth oxidation channels (Fig. 1). Fish raceways allow excellent inventory and health management, and improve predator control, feeding, and harvesting efficiencies. The algae in the oxidation channels control organic and nitrogenous wastes and allow reuse of culture water to produce oxygen and detoxify waste nitrogen.

Partitioned aquaculture yields more fish than earthen pond culture while using much less water.

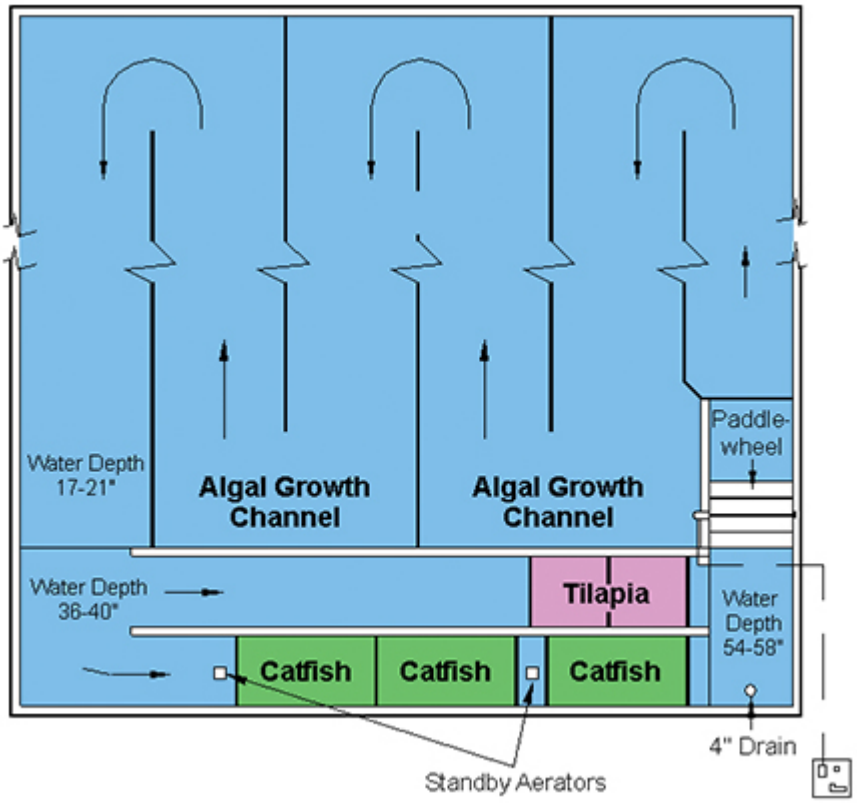

Fig. 1: Representation of a partitioned aquaculture system unit as operated at Clemson University in 1995.

Algal-fish dynamics

In the PAS, inorganic nutrients (waste products) released by the cultured fish (catfish) are fixed by phytoplankton, cyanobacteria (blue-green algae), and green algae, which are then harvested by filter-feeder fish such as tilapia.

The harvesting of algae is an important component, as the algae remove potentially toxic ammonia and increase nutrient retention and conversion into fish flesh. Harvesting algae also helps to reduce the algal cell age in the water column, which in turn increases algal growth, the removal of waste, and production of oxygen.

Elements of a commercial-scale PAS at Clemson University.

PAS water routinely contains several green algae and cyanobacteria taxa over the production season. The dominant green algae taxa are usually *Scenedesmus* and *Ankistrodesmus*, while *Microcystis* is the dominant cyano-bacterial taxa in the water column.

Filter-feeding experiments

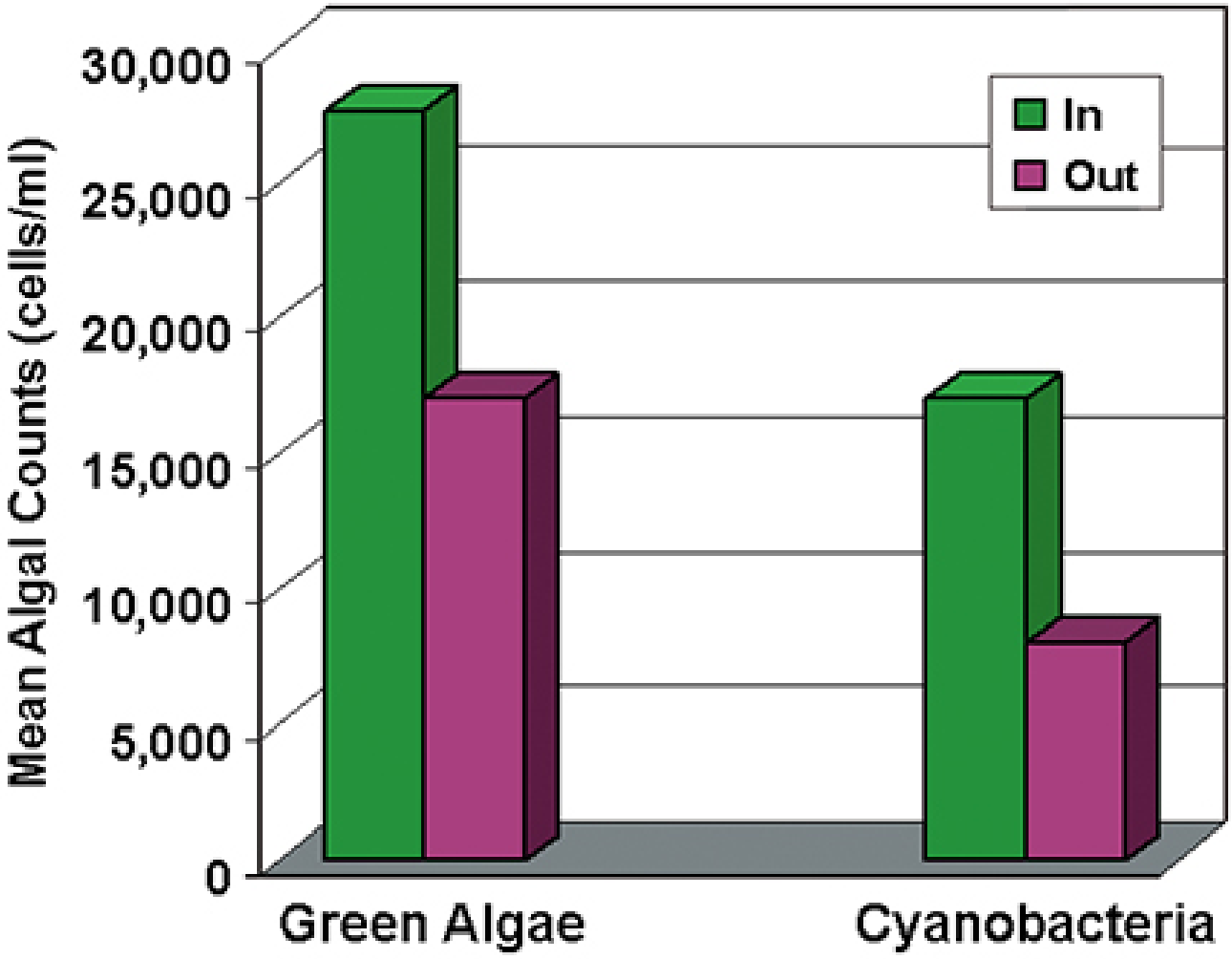

Fig. 2: Mean algal counts of incoming and outgoing (filtered) green algae and cyanobacteria dominated PAS water.

Four 0.01-ha experimental PAS units are dedicated to the quantification of the algal filter feeding kinetics of Nile tilapia (*Oreochromis niloticus*) and other filter feeders. The filter-feeding rate of Nile tilapia was estimated in timed, pulse-fed, filter-feeding chambers as mg particulate organic carbon (POC) of green algae and cyanobacteria.

Filtration rates were fit using Ivles's 1961 model against POC concentration for green-algal and cyanobacterial water source. Algal taxa abundance in the incoming and filtered outgoing water was counted to estimate tilapia's filter-feeding selectivity of green algae and cyanobacteria.

Observations

The filter feeding of Nile tilapia significantly reduced *Scenedesmus* and *Microcystis* in PAS water (Fig. 2). Filtration rates increased with POC concentration up to the maximum rate (Fig. 3).

The maximum filtration rate for cyanobacteria was significantly higher than green algae. The half-saturation coefficient for the tilapia filtration rate in green-algal water was lower than in cyanobacterial water. The lower half-saturation coefficient indicated a faster increase in filtration with increased POC concentration. The equivalent daily feeding rate (dry weight phytoplankton per wet weight fish) was 3.1 percent for green algae and 4.2 percent for cyanobacteria.

Conclusion

This research represents a first step in determining the biomass of Nile tilapia needed to control plankton growth in fertile partitioned aquaculture system water. The results also suggested that the use of Nile tilapia as a biological control of nuisance algae that can cause off-flavor in fish flesh (e.g., *Microcystis*) is a promising management tool for the PAS.

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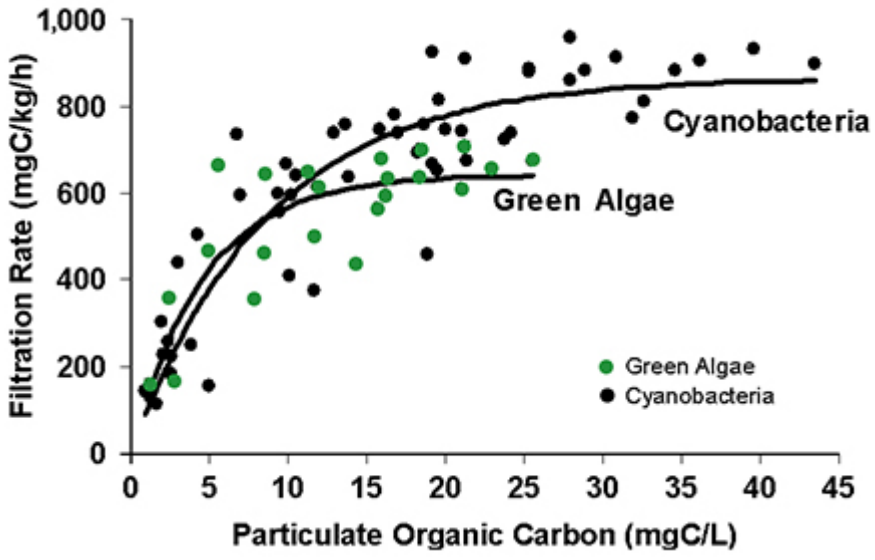

Fig. 3: Filtration rate of green algae and cyanobacteria by Nile tilapia.

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